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We believe New York city will soon realize that it owes a large debt of gratitude for the building and equipment of its subway system. The three names that stand out as worthy of high praise are August Belmont, the financier; John B. McDonald, the contractor, and E. P. Bryan, in charge of the equipment and the operation of the system.

These gentlemen have surrounded themselves with the ablest men available, and have been particularly fortunate in their selections for the responsible electrical and engineering work. The greatest care has been exercised throughout, and most careful study and experiment have been required, as in many respects the development of the New York subway system has required wholly original plans of procedure.

Mr. L. B. Stillwell, in charge of the electrical work, has been the right man in the right place, and the electrical fraternity, we are sure, will take a just pride in the evidence of comprehensive electrical development which he has so carefully and broadly carried to practical completion.

EFFECTS OF ALTERNATING AND DIRECT CURRENTS ON INSULATORS.

During some tests made recently in Switzerland it was found that insulating materials will give higher breakdown tests if tested with direct than when tested with alternating currents. Five different types of insulators were tried, and the ratio of the direct-current breakdown voltage to the alternating varied from 1.31 to 1.6. Tests on pressboard showed the same results. Material which broke down at 9,000 volts alternating current after application for 130 seconds, did not break down with direct current until 25,000 volts had been reached, and until this had been applied for four minutes. Tests upon marble gave similar results.

High-Tension, Direct-Current Transmission Suggested.

It is thought that the results of these tests indicate the possibility of using direct current for transmitting power at a higher voltage than we are at present able to use with alternating currents. One advantage of the direct current would be the elimination of dielectric hysteresis, but, on the other hand, there would be some danger of electrolysis which might be disastrous.

Supposing, however, electrolysis gave no trouble, there are other and more serious drawbacks to direct-current transmission. At present the only high-tension, direct-current transmission systems in existence operate with their motors and generators in series, and while this system eliminates expensive and complicated switching, it introduces other objectionable features, such as difficulties in commutation and the general inflexibility of the series system which seem to condemn it from the beginning.

THE CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION.

The recent convention of the American Street Railway Association, held at St. Louis, Mo., was the twenty-third annual meeting of this important organization. Less than 200 of the 800 street railway companies in this country are now represented in the association, but President W. Caryl Ely predicts that by next year the organization will have doubled. Although the association is devoted to street railway interests in general, the overwhelming preponderance of the electric railway has a noticeable influence upon its proceedings. Then, too, the development of the interurban railway from the street railway, and the entrance of the latter in competition with the steam lines, broadens to a marked degree the field with which this organization deals.

The work of the convention was most successful. A number of the papers read were of great value, as were the discussions. The address of President Ely deserves special mention, as in it he outlines a policy which should enable the association to accomplish the greatest good.

SMALL WATER POWERS.

Great water powers, like Niagara and Spier Falls and Sault Ste. Marie, and their electrical development and transmission, have received much attention. Thousands of small water powers, on the other hand, have continued to run to waste almost unnoticed. Large centres of population and great industrial plants have generally been the objective points of transmissions from water powers of the first importance, except as to small cities and towns that lie along the route of some main line.

Attention will surely turn however, sooner or later, to the numerous small water powers, and they will be transmitted to the minor centres of population. In this way a very large class of small water powers will be made to operate electrical supply systems that are now entirely lacking or else depend on steam. The small water powers will contribute to electrical supply in cities and towns of moderate population rather than in large ones, because it is not economical to transmit small powers over long distances, and because the minor centres of industry are comparatively near-by.

That powers very great in the aggregate are represented by the numerous small streams and rivers that seek the ocean level in every part of the country is beyond question. Over a great portion of the area of the United States the annual fall of rain and snow represents a layer of water from two to five feet thick. Most of this water flows down the small streams in its journey to the lakes and ocean, and the total energy transformed from mechanical motion into heat by its fall is more than enough to replace the entire amount annually obtained from the combustion of coal. Large parts of the area of the New England, central and southern states are 500 to 1,500 feet above sea level, and the streams on their way to the ocean must fall corresponding distances. Even the great plains of the Central West lie, in large part, at elevations of 500 to 2,500 feet above tide water. Many of the streams in that section, though destitute of waterfalls, have for hundreds of miles along their courses a nearly constant slope of bed amounting to as much as five feet per mile, and most of them can be made to yield large parts of their power. In the entire Rocky Mountain section the streams have elevations of 1,000 to 10,000 feet, and the numerous powers available for development are fairly large even with very small volumes of water, because of its great head. The fall of only one cubic foot of water per second through a height of 100 feet develops 11.2 horse-power. A striking example of the amount of power that may be developed by what appears to be trifling quantities of water may be drawn from one of the plants on Mill creek, in southern California, that forms a part of the electric system that reaches Los Angeles by a transmission of eighty-three miles. At this power-house the head of water is a little more than 1,900 feet, and the fall of a single cubic foot of water per second therefore develops 117,800 foot-pounds during that time, or 214 horse-power. As a rule the heads of water available on small streams are much greater than those on the large rivers, because the water is gathered on the higher lands by the former and then delivered to the latter in the low lands. Very few large rivers offer high heads of water for the development of power. Hundreds of small streams in various parts of the country offer as great heads as that at Niagara for power development. Spier Falls on the upper Hudson river has been developed by a great dam, so as to give a head of eighty feet.

On the Sault Ste. Marie the head of water at the great electric power plant is twenty feet. At Cañon Ferry, in Montana, the Missouri river falls over a dam that gives a head of thirty feet for the water-wheels that develop power for Butte, sixty-five miles away. And the list of great powers with only moderate heads of water might be much extended.

The greater heads of small streams over the larger rivers tend to cheapen the cost of hydraulic and electrical development on the former. As pointed out above, the power that can be developed with a given quantity of water per second varies directly with the head or distance through which it falls. So a high head means a comparatively small amount of water for a given power, and a consequent reduction of necessary investment in storage works, canals, pipe lines and penstocks. The power of a turbine wheel of certain dimensions increases directly with the head of the water that passes through it, so that a high head yields a required power with a relatively small, cheap wheel. A small turbine has a higher economical speed of rotation than a larger one would, and, as wheels and electric generators are generally direct-connected, the higher the speed of the former the less is the weight and cost of the latter. Small water-wheels and electric generators per unit of capacity imply also a relatively small building for the power-house.

No doubt a great water power, even at a moderate head, can be electrically developed at a lower total cost per unit than a much smaller power at a much greater head, all other factors being equal. The high heads of small water powers, however, strongly tend, as pointed out, to bring their cost of development per unit down to that of much greater powers at low heads.

A large number of small water powers have already been developed for electrical supply, particularly in the New England states, but a far greater number remain undeveloped or idle. In the state of Maine, where water powers are perhaps more numerous than in any other part of the country, fully eight-tenths of the entire number of electrical supply systems great and small draw their energy in whole or in part from water power. Electrical development and transmission seem to be the only practicable means by which the great majority of small water powers can be brought into use. These powers are usually more or less distant from even the smaller centres of population, and as a rule manufacturing industries will not go to them. In cities and towns the lighting, small motive power and heating loads must, of course, be supplied where wanted, and this is also true for mines and electric railways. So strong are the forces at work for the centralization of industry, either within cities and large towns or in great manufacturing plants, that numerous small water powers which once turned the wheels of local mills are now abandoned and running to waste. Since the work to be

done can not be taken to the small water powers, the energy from these powers must be transmitted to it. Though the nearness of small water powers to the minor cities and towns renders transmission to the latter comparatively easy, it is practicable in many cases, by combining such powers electrically, to make longer transmissions to the larger cities. Thus the energy developed by four waterfalls on two rivers is transmitted into Manchester, N. H., from a maximum distance of fourteen miles. Five small water powers on two streams all pour their energy into Mexico City over a transmission line about twenty miles long. By short, single or longer combined transmissions the small water powers can thus be made to do their part in the supply of human wants.

UNDERPAID INSTRUCTORS.

Attention was again called to the inadequate pay received by scientific teachers when Sir William Ramsay, at a recent dinner given in his honor, dwelt upon this unfortunate feature of our educational system. The eminence of Sir William in science makes his remarks of exceptional value, and gives those who are interested in advancing our educational system to the point of greatest efficiency a good opportunity to bring this important matter to the attention of the public again.

Without in any way attributing to the teacher of science or applied science a greater value than that accorded to any instructor, it is nevertheless true that the man who has become prominent either in pure science or applied science, by putting his knowledge to practical use, can obtain far better returns than he can get by teaching. This would mean that all those who are best fitted for teaching would be drawn into other fields, were it not fortunately true that there are many of the first ability who, for the love of teaching, are willing to forego greater worldly gains. But this is a factor upon which it is neither safe nor right to depend. However devoted he may be to teaching, if there are others who have claims upon the instructor he must consider them, and their welfare and happiness may demand that he take the more lucrative position. The example—now becoming more general—of allowing engineering teachers to practice improves the situation considerably for those who are able to do this, but unfortunately there are only a few schools so located that the instructors can do outside work.

The condition resolves itself to this: if we are to occupy the first position in the world we must have the best schools of science and engineering. We can not have the best schools unless we have the best instructors, and we can not keep the best instructors unless we pay them as much as they are worth to others. Conditions have improved somewhat during the last few years, but apparently the only way in which a safe position can be reached is by bringing the matter to public attention at frequent intervals, in order that it may sooner or later realize what is required. It is too much to expect that the school authorities will take a stand for higher salaries unless they are backed by public sentiment.

ELECTRIC AID FOR FIRE FIGHTERS.

The city of Manchester, England, has recently put into service a fire engine which would seem to be a most valuable addition to its equipment. This engine is not only self-propelling, but it is fitted with a dynamo, an air pump, and a telephone system. It is intended primarily for assisting the firemen in rescuing persons overcome by smoke, and in fighting fires in situations where the firemen could not stay for a moment without the aid furnished by this engine. Each fireman is supplied with a hood, to which is attached an air pipe, a telephone and an incandescent lamp. He can thus penetrate into buildings through suffocating smoke and fumes. His supply of pure air enables him to breathe in the foulest atmosphere; his lamp assists him in finding his way, and by means of the telephone he receives orders from his chief, and asks for assistance and reports the conditions in the building.

The additional equipment on the fire engine which brings so many valuable aids to the firemen is not very elaborate. A small dynamo supplies eight thirty-two-candle-power incandescent lamps. It, as well as the air pump, is driven from the flywheel of the steam pump. The telephone adds little in weight or complexity. We would be glad to see every city in this country furnished with one or more engines equipped in this way. Effective use of such an equipment, either in saving lives or in extinguishing a dangerous fire at its start, would easily pay for the equipment many times over. We are not usually behind in our apparatus for saving life and property, but here, at least, may we not learn a lesson from abroad?

THE USE OF MOTORS IN TEMPORARY WORK.

It is rather surprising not to see more electric motors employed for work of a temporary character, such as erecting buildings, excavation, and in other places where a convenient source of power is needed. For such purposes the electric motor would seem to have commanding advantages. There is no large city to-day without its electrical supply, from which necessary power could be drawn at a cost considerably less than it could be obtained by means of the semi-portable steam engine which is practically in universal use to-day. The motor would save over the engine, not only in the cost of power, but in labor, for it requires no attention when not in actual use, while it is necessary that a steam engine have constant attendance. Moreover, the motor is always ready for work, while the steam engine requires time for raising steam. Again, the motor wastes nothing when idle, while the consumption of coal in the engine goes on whether it is busy or not. As regards the relative ease of manipulation, there is no machine which is capable of more delicate control than the electric motor, and we doubt whether the upkeep of the motor, although it would probably be subject to rough usage, would be any greater than that of the engine. It would probably be less. The electric motor has been so entirely successful in other fields that there should be no doubt whatever of its immediate success in this work once it is tried.

High-Tension Lines.

By H. Parker Gibbs.[1]

THERE have recently appeared in various Institute proceedings and technical journals some rather interesting articles by various authors on the above subject, but as in most articles there are usually a good many interesting features lost sight of, and then again inferences are drawn (which are not thoroughly grounded) from work already installed which are oftentimes misleading—as for instance, our Cauvery poles were referred to in a recent article in terms more flattering than warranted—it will be the endeavor in this article to bring out a few of the most essential points with opinions based on experience.

THE IMPORTANCE OF THE LINE.

I think it is now generally agreed that the average transmission line is the weakest component of a high-tension transmission system, and unless a marked improvement in its construction is made it must, in the author's opinion, continue so to be in the future.

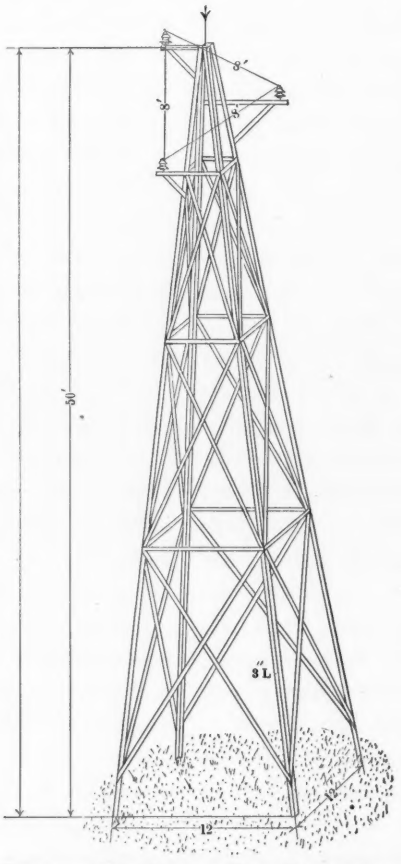
Transformers and general station appliances are now made to stand up to their work most nobly, and an occasional trouble (which fortunately is now of exceeding rare occurrence) with a generator, transformer or other apparatus in a well-designed station seldom seriously inconveniences the general service to any considerable extent. With the line, however, it is very different, and unless it is built in duplicate serious annoyances are probable, and even then we may by no means get off absolutely free from total stoppages.

The line is really at the present day a comparatively weak but all-important link connecting the isolated source of power with the available market, and far too often breaks, leaving all machinery, of supplier and supplied alike, idle until the connection can be restored; and the most annoying feature of it all is, that a very small thing may cause so great an inconvenience.

If a step-up and step-down station were installed so closely adjacent to one another that they could be connected with a single span of wire, a complete shutdown of the entire service should indeed be a decided novelty, and it should be the aim of all electrical engineers of the day to work most diligently toward the end that complete shutdowns shall also yet become a novelty, even though one hundred or more miles may intervene between the two stations. What then are the lines on which we must work in order that we as a body of colaborers for the general advancement of our generation may hope to ultimately succeed in so doing? It seems to me that the successful transmission is almost entirely dependent on the following four factors:

1. Substantial, long-lived supports.
2. Conductors of great tensile strength, and yet good conductivity.
3. Improved insulators.
4. Good lightning protection.

A great step toward the accomplishment of the above conditions has already been taken in the erection of a transmission line on steel towers using hard-drawn, stranded copper cables with comparatively long spans. Our four conditions may then be considered as follows:



PROPOSED HIGH-TENSION LINE TOWER CONSTRUCTION.

1. When light steel towers are used and spaced at good intervals the aggregate cost may be made considerably less than when using iron poles with the old time-honored spacing of from 100 to 150 feet, and when compared with wooden poles will in the long run work out very favorably in point of comparative cost when the great difference in life is considered, particularly in the tropics.

The writer has had considerable experience with pole lines in the tropics and would say that in these climates in general and this section of the far east in particular, he unhesitatingly condemns the wooden poles for any usage, as they are a constant source of trouble from such causes as warping, sun-cracking and dry rot as well as being subject to destruction by the hordes of insects which infest these sections. A wooden pole to be serviceable here must have an iron socket reaching some feet above ground-level, so that if a wooden top is used the socket must be large, and as we have proved by actual test and comparison a far more substantial pole all iron may be obtained at a lesser cost.

There has recently been considerable controversy regarding the proper spacing of cables in long spans to prevent contact when strong winds are blowing. On long spans which we have at river crossings, reaching in one case to 586 feet clear span we have never observed a movement of the cables exceeding two and one-half feet either way from their normal positions. I am submitting herewith a drawing showing a method of tower construction which places each wire on a plane by itself and makes such contact almost impossible.

2. It should now be the aim of all manufacturers to produce a conductor not only of high conductivity, but of high tensile strength as well. We might easily sacrifice a few per cent in conductivity, as after all in the aggregate cost of installation of a large important plant a slightly increased cross-section and cost of conductor would be almost negligible. A conductor can now be obtained in stranded hard-drawn copper cable, which has a tensile strength of 60,000 pounds per square inch; why should we not have a conductor of 100,000 pounds tensile strength as a preliminary step in the right direction? A composite cable might possibly be made which should answer; however, I sincerely hope that this phase of the situation will not be lost sight of.

There is, I think, little doubt but that in estimating for strength in line construction the tendency in the past has been to err on the side of safety. This

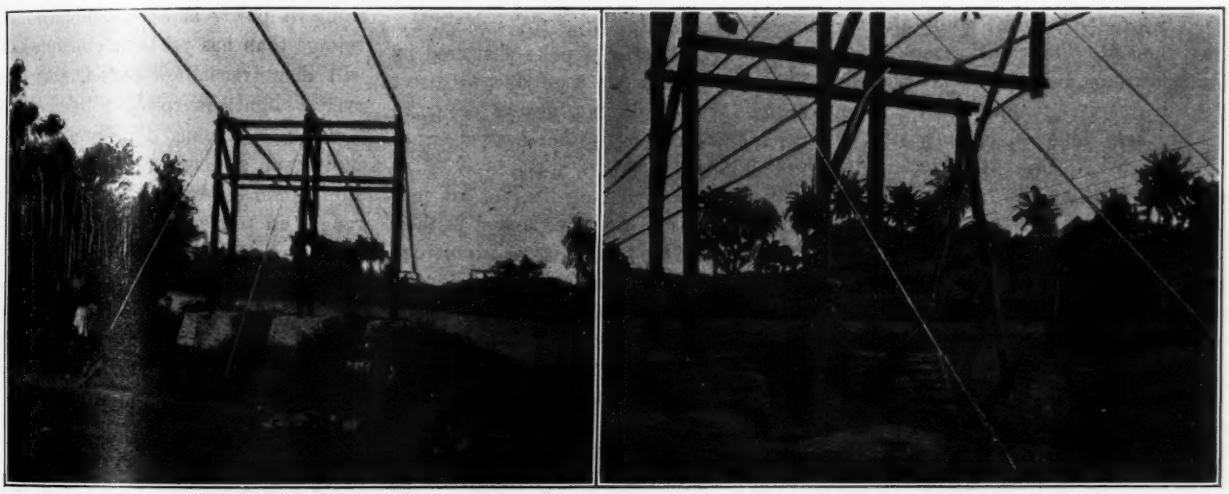
[1] Chief electrical engineer to government of Mysore, Bangalore, India.

is not altogether so in latitudes where wires are liable to be heavily loaded with ice just at that particular time when the heaviest wind prevails and their increased weight as well as greatly increased effective area exposed to the wind pressure cause abnormal strains. On a line in constant service the C^2R heat may or may not be sufficient to prevent this, but it may happen to lines when they are idle. Is it not the practice to estimate for just as strong a line even when used in the tropics? There may surely be a considerable discrimination between the two conditions. The writer has never known of a case where a wire has broken excepting at such times as when a heavy tree falls on them or other equally aggravating abnormal conditions are experienced against which we should not be expected to figure in design.

At our Akavatha river crossing the 586-foot span is supported as shown in Fig. 1. The wires are ten feet apart with a normal sag of ten feet. The conductors are of silicon bronze and equal to a No. 1/0 B. & S. copper wire. During high water last year the stone foundations were undermined as shown in Fig. 2. This happened in the evening, and owing to the excessive shock received, the line was short-circuited which resulted in shutting down the plant. The plant was immediately started, the line testing clear was charged and work resumed and continued through the night. As may be seen by careful observation of the photograph one wire of this long span had entirely lost its two outer supports and the entire strain was taken up by an ordinary medium drawn 1/0 copper wire to which it was joined.

The pole sockets are extra heavy hydraulic seven-inch pipe and one was bent to almost forty-five degrees by the force of water against the dislocated portion of the foundation. A slight idea of what our present conductors will actually stand in an emergency may be gathered from this experience.

On the same structures were the telephone wires, also of bronze. They were submerged at the centre of span and were broken presumably by debris carried along by the river. We had no bronze to replace them and so put up ordinary No. 10 B. & S. copper which has gone through a wind which slightly exceeded fifty miles per hour. I have recently recommended a line for a large prospective enterprise in this locality to be carried on steel towers with 660-foot spans containing six spans of 1,000 feet, and I hope to soon see spans of this latter mentioned length in common practice.



THE TRANSMISSION LINE AT AKAVATHA, INDIA, SHOWING FOUNDATIONS BEFORE AND AFTER A FLOOD.

3. Regarding insulators there is perhaps little to be said by one who is so far away from the centres of manufacture, but a better insulator can surely be made or at least one which will work satisfactorily under higher normal working pressures. Such insulators might be very expensive on the old line construction, while on the new the number is so greatly reduced that we can well afford to pay considerably more if necessary. The insulator must be much larger and stronger, which means much longer leakage surface. Punctures should not be experienced except on damaged or imperfect insulators. For the better high-voltage insulators we now pay about $1.50. For our long span work we can afford to pay $3 or $4, which should ensure us against most forms of insulator troubles.

4. This is a most interesting subject and one which demands a great deal of careful consideration and intelligent investigation and I imagine that a few of our experiences during the past two years will be of interest to all readers.

First, however, I would say that I believe in the steel tower as a protection against lightning. We have at least two forms of lightning phenomena. One is the direct stroke and the other the high-pressure inductive charges taken up by our lines from atmospheric disturbances in their vicinity. The first usually seems to please itself as to what course to ground it shall take, while the latter, I believe, is the condition under which our ordinary protective devices usually come in and do their little part. I am further thoroughly convinced that the lightning arrester of to-day is not a positive protection even in the second case. Mr. Davis, in the *Street Railway Journal,* of June 25, quotes our Cauvery composite pole as being probably the best form of construction for our climate. Our experience in the operation of this line does not warrant my coinciding with him in his opinion. He further commends it as a protection against lightning. This latter opinion is not substantiated either, as we have had several poles absolutely shattered.

During the course of a year we find it necessary to replace several poles, sometimes owing to dry rot at that portion of the pole which is in the iron socket. Occasionally one is destroyed by insects, and several are shattered by lightning, while now and then a crack occurs of such magnitude as to require a renewal. While running with one leg grounded through a cracked insulator we burned a pole so badly as to necessitate renewal

owing to its bad contact within the iron socket. Were we depending on a single line each of these cases would mean a considerable shutdown. I do not consider such a pole as half good enough, but believe that a line construction should be attained of so substantial a character that a single line could be at least practically dependable when a system has to be so closely figured from a financial standpoint as to make the duplicate line unfeasible.

The Cauvery plant is equipped with the standard General Electric lightning arresters with carbon resistances, which are at present installed at the two ends only of a ninety-two-mile duplicate line working normally at 30,000 volts. A fair number of discharges over the arresters have been noticed and in some cases the lightning has gone by them.

On two occasions lightning discharges have been observed to enter a transformer and go to ground without doing any apparent damage. The transformers are of the air-blast type, the report was distinctly located in a given transformer, a flash distinctly seen followed by a raising of dust projected through the ventilating openings at the side and top. My theory is that the discharge was of a comparatively mild nature, did almost no damage to the insulation, and happened at just the opportune instant of zero electromotive force so that the discharge was not followed by the working current.

On one occasion a transformer was punctured by lightning, the current followed shutting down the plant and leaving the transformer *hors de combat.*

At another time we were trying to locate a ground by keeping it charged through a bank of our regular transformers, and although we succeeded in burning off the pole and locating the ground, we also punctured a transformer coil owing to the severe static strains in the system. We now have a special testing transformer for this purpose.

As an example of static effect on telephone lines during grounded conditions of the transmission line the following will no doubt be very interesting. Our telephone wires are six feet below the transmission wires, and, being of copper, are useful to the native jeweler for alloying gold, whereby the copper no doubt ultimately brings a good return. We suffered for months by interrupted telephone service owing to frequent thefts of the wire at night and finally decided to keep our telephone wires charged at night, using 1,000 volts. This was accomplished by connecting through a type H transformer, stepping up from 110 volts with the two high-voltage coils in parallel. Small potential transformers for 2,080 volts were installed at each telephone station with a 110-volt pilot lamp to burn at half voltage. By means of a double-throw switch either telephone or transformer may be connected to the line. From 6.30 P. M. to 6 A. M. the line is charged and pilot lamps indicate the condition. Signals are arranged whereby the step-up and step-down stations may get the use of the telephone if required at night. This has now gone on for over four months and seems a decided improvement on police.

During May we were running one day with a ground on the main line through a cracked transmission insulator. The lamps were seen at half voltage and eventually three were burned out, although on that night the telephone line was not charged as usual.

Our several cases of poles shattered by lightning I consider were due to direct strokes. They do not always occur in the high places, but rather near rivers or wet ground.

We have no reactive coils, but are now installing them. As an argument in their favor I cite the following case: on one occasion a discharge entered a transformer and jumped to ground from the point where the transformer lead enters the winding. It was no doubt effectually resisted by reaction due to the inductance of the winding.

We are now installing two section stations where by means of switches each of the two lines may be divided into three sections. Interconnection can be made between lines at these points so that at times of line repairs but one-sixth of the line copper need be cut out. By means of switches mounted on line insulators between anchorages the section switches may be short-circuited and then cut out. Lightning arresters will be installed in each of these houses, and the locating of trouble will be greatly facilitated.

With the steel tower, as shown in my drawing, I believe direct lightning strokes will be taken care of, but that lightning arresters, well grounded, will still be required for inductive discharges. The greatest possible care should be observed in making ground connections for lightning arresters. A plate of copper should be placed so as to always reside in the earth's permanent moisture. In my opinion such plates should be no less than four feet square, thus giving an effective contact area of thirty-two square feet. The copper strip from the lightning arresters should be sufficiently strong, mechanically, to ensure them against accidental breakage. If fine coke is used the contact is much improved over coarse. I should always recommend at important points that two such grounds be made, absolutely separate. One great advantage of this arrangement is that their condition at all times can be so readily checked by simple tests. For further protection the lightning rod support at the top of tower shown might be of pipe sufficiently strong to carry a steel wire of high tensile strength. Barbed wire is not of sufficiently good quality.

CONCLUSION.

My idea of the successful line of the future is one which will be economical to build, sound mechanically and light as practical; one over which we may readily transmit power at a considerably higher voltage than has yet been attempted. We will then transmit a considerable power over a light, inexpensive line with no necessity of placing duplicate circuits on individual structures, but enable us to afford two complete lines suitably arranged in sections so that an occasional line trouble may not cause serious inconvenience.

Make the structure light and substantial, the insulators large and strong, the conductors small and of high tensile strength—then raise the voltage.

Telephones in New Brunswick.

United States Consul-General Holloway, at Halifax, N. S., reports that the Central Telephone Company, of New Brunswick, contemplates combining with the Union Telephone Company, of the same province. In addition to these two there is a third, the New Brunswick Telephone Company, operating in the up-river counties. If the reported combination is carried through there will be two strong rival companies in the province. All of the companies are now extending their systems.

News Service on Trains.

The Union Pacific Railroad Company will shortly begin to issue news reports on the Overland Limited trains. This service will be sent out at noon and in the afternoon and posted in the cars. The matter will be sent out over the company's private wires.

STANDARDS OF LIGHT.[1]

BY PROFESSOR EDWARD L. NICHOLS.

The conditions demanded of a physical standard are very far from being fulfilled in the case of the existing standards of light. The standard should be suitable and convenient for the purposes for which it is to be used, capable of precise definition and reproducible; and it should if possible stand in some simple relationship for our absolute system of measurement. The history of the art of measuring shows that in the beginning standards are selected from familiar and easily accessible sources. The questions of accuracy and reproducibility come in later for consideration, and that of relations to absolute systems last of all. Thus we have for primitive standards of length the foot, the hand, the pace, etc.; for standards of mass the pennyweight, the stone, etc.; for standards of liquid volume the drop, the teaspoonful and the cupful; as a standard of activity the horse-power.

The fact that the candle is still, nominally at least, our standard of light indicates that in photometry we are still in an early stage of development. The persistence of this term in our nomenclature marks, as does the continued use of the word horse-power, as applied to engines, the natural conservatism of the race. The term candle-power is at present, like horse-power, a survival, but both are likely to persist for a very long time to come. We have, however, in photometry at last and forever abandoned the futile attempt to standardize the actual candle, although it still stands in law as a unit, and have turned our attention toward the establishment of units of light which fulfil more nearly the requirements of a scientific standard.

The development of standardization in photometry is following a somewhat different course from that which has taken place in electricity and in mechanics. In the case of the metre and the kilogramme, which it was originally proposed to establish in terms of the dimensions of the earth, and the density of water, we have receded from the original standpoint and as a matter of convenience content ourselves with making copies of certain prototypes which are known to fulfil only approximately the original definitions. Of our three fundamental electrical units the ohm alone seems likely to be maintained with strict relation to the centimetre-gramme-second units, while for the others we are inclined to the more convenient values obtained from the chemical equivalent of silver or the electromotive force of the standard cell; using such reduction factors as shall bring the volt and ampere into sufficiently close approximation to the absolute units.

In the case of the standard of light we

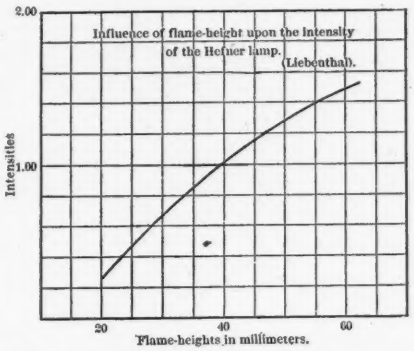


FIG. 1.—INFLUENCE OF FLAME-HEIGHT UPON THE INTENSITY OF THE HEFNER LAMP.

are forced by circumstances to content ourselves for the present with finding some reasonably reliable and practical unit. When we have found this it will perhaps be possible to establish the numerical factor by means of which to express it in terms of ergs of luminous energy per unit of time.

In the search for a practical standard of light the photometrician has before him the following possibilities:

1. The use of a standard flame.
2. The use of an incandescent body of a fixed temperature.
3. The use of a luminescent body.

The numerous studies of luminous

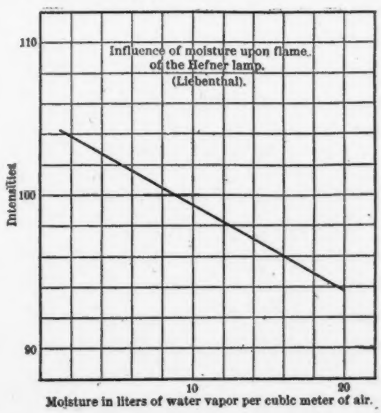


FIG. 2.—INFLUENCE OF RESISTANCE ON THE FLAME OF THE HEFNER LAMP.

flames which have been made in the attempt to secure a suitable standard of light have shown that in order to secure even approximate uniformity it is necessary to have a fuel of definite composition consumed under constant conditions. Of the various candle, oil and gas flames proposed as standards in the past, none conforms to these conditions. The futile struggle of a century of photometricians with candles of spermaceti, paraffin and stearine and the endeavors of the various expert commissions appointed for the purpose of determining the relations between the standard candles adopted and legalized in different countries have only served to demonstrate the worthlessness of the candle, whatever its composition and construction, as a standard of light.

The only fuel of strictly definite composition which it has been found possible to subject to constant conditions of combustion is amyl-acetate. The thorough and careful manner in which the lamp for burning this fuel introduced by the late Hefner-Alteneck has been developed is well known to all students of photometry. Thanks to the investigations of Liebenthal and to the work of the German gas commission and of the members of the Reichsanstalt at Charlottenburg, we know, with as great a degree of precision as the nature of the subject will permit, the influence of flame height, of temperature, of atmospheric moisture, of the presence of carbon dioxide in the air, and of atmospheric pressure upon the illuminating power of its flame.

It has been found as the result of these investigations that when lamps constructed strictly of the prescribed dimensions and materials are used under normal conditions of atmospheric pressure, moisture, etc., the illuminating power is reproducible to within two per cent. This performance so far exceeds in uniformity that of other known available photometric standards,[1] that the Hefner unit has very properly been adopted by photometrists as the best primary standard in spite of the fact that the quality of the flame is such as to seriously interfere with satisfactory comparisons between it and the whiter and more brilliant sources of light used in modern illumination.

In view of the general acceptance of the Hefner lamp as the primary standard, in terms of which candle-power is to be defined and by comparison with which secondary standards are to be calibrated, I have brought together for convenient reference the following data concerning this source of light.

PHYSICAL CONSTANTS OF THE AMYL-ACETATE FLAME.

In addition to the investigation of the effects of flame height upon the intensity

[1] Presented before section A—general theory—at the International Electrical Congress, St. Louis, 1904.

[1] A possible exception to this statement is the modified form of pentane lamp largely used by gas photometrists in the United States, for which a performance comparable to that of the Hefner lamp has been claimed. This source, however, in spite of the good accounts given of it and the superior whiteness of its flame, is open to objection, as a primary standard, on account of the indefinite character of the fuel employed.

of the Hefner lamp, the results of which are shown in Fig. 1, of moisture, see Fig. 2, and the effect of the presence of carbon dioxide in the atmosphere upon the intensity of this source of light (Fig. 3); all of which are plotted from data published by Liebenthal,[1] we have a more precise knowledge of the physical contents relating to this flame than of any other source of light.

Koettgen[2] has compared the flame of the Hefner lamp spectrophotometrically with numerous other artificial sources of light, especially with various oil and gas flames. While the results are strictly applicable only to the particular flame measured in each case and only approximately to other flames of the same type, the curves giving the relative distribution of intensities in their spectra are of interest since they describe as completely as the circumstances will permit the color relations of such flames. Two such curves plotted from his tables are shown in Fig. 4. They are drawn in the usual manner with wave-lengths as abscissæ and the ratio of the intensities for each wave-length of the spectrum divided by the same ratio, for the region of the D line, as ordinates. It will be seen from these curves which refer respectively to an ordinary gas flame and the flame of a petroleum lamp, that the light of the Hefner lamp is relatively stronger in the red and weaker in the violet than the ordinary sources of light used in artificial illumination; and that, consequently, we should expect to find that the temperature of this flame is lower than that of our ordinary oil or gas flames.

Knut Angström[3] in a recent paper has published data which define the physical constants of the Hefner flame in absolute measure. By means of a spectrobolometer he first explored the infra-red spectrum as far as 5 μ. The resulting curve is of the general form which one would expect for a flame of this character. It shows the strong emission band due to CO_2 at 4.4 μ and has its maximum, as is to be expected from the character of the spectrophotometric curves already given, at a greater wave-length than is the case with other luminous flames. G. W. Stewart[4] has found the maximum for the candle at 1.25 for the ordinary gas flame at 1.13 μ and for the acetylene flame at 1.05 μ.

[1] Liebenthal. *Elektrotechnische Zeitschrift*, 1888, p. 204; ibid. 1895, p. 655.

[2] Koettgen. *Wied. Ann.*, liii, p. 793.

[3] Angström. *Physical Review*, vol. xvii, p. 302.

[4] Stewart, G. W. *Physical Review*, xv, p. 311.

Angström[1] has likewise determined the radiant efficiency of the Hefner lamp. He assembled upon the face of the bolometer the entire energy of the spectrum of the amyl-acetate flame and observed the total radiation Q. An opaque screen, which cuts off all wave-lengths greater than 0.76 μ, was then interposed, and the

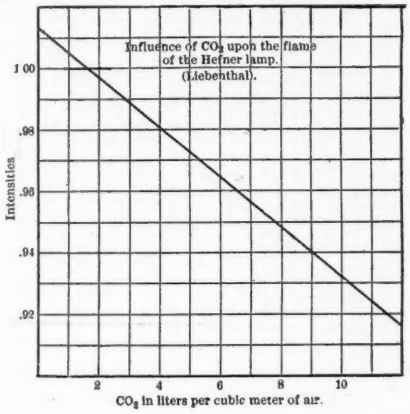


FIG. 3.—INFLUENCE OF CO_2 UPON THE FLAME OF THE HEFNER LAMP.

remaining radiation L, which constitutes the whole of the visible spectrum, was assembled upon the same bolometer, and measured. He finds for the ratio of these two quantities

$$L/Q = 0.0096$$

where L is the luminous energy and Q the total energy of the flame.

The unit of illumination, the lux or bougie-metre has been defined as the illumination received from the Hefner lamp at a distance of one meter. By the use of his compensated pyr-heliometer Angström has succeeded in determining this quantity also in absolute measure. He finds for the total radiation corresponding to the lux,

$$Q = 0.0000215 \frac{\text{gram.-cal.}}{\text{sec.-cm.}^2}.$$

From the value of L/Q already given it

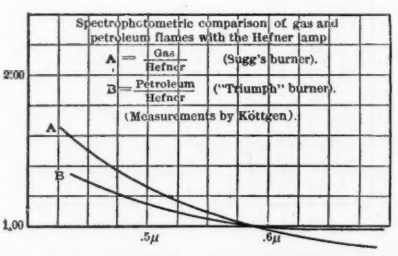


FIG. 4.—COMPARISON OF GAS AND PETROLEUM FLAMES.

follows that the luminous radiation corresponding to the lux is

$$L = 20.6 \times 10^{-8} \frac{\text{gram.-cal.}}{\text{sec.-cm.}^2}.$$

Tumlirz[2] has determined by a different method the value of the luminous radiation corresponding to the lux. He obtained a somewhat larger value than Angström but of the same order; *viz.*

$$L = 36.1 \times 10^{-8} \frac{\text{gram.-cal.}}{\text{sec.-cm.}^2}.$$

In other words according to the determination of Tumlirz a surface of 1dsq. cm. placed in the horizontal plane passing through the centre of the flame of the Hefner lamp at a distance of one metre receives in one second an amount of light the energy equivalent of which is 3.61×10^{-9} gram.-cal.

By pushing the opaque screen further and further into the luminous spectrum Angström found it possible to measure the energy L_λ of portions of the spectrum lying between the ultra-violet and the position of the screen for a number of different settings of the latter. The quantity of energy measured in each case is

$$L_\lambda = \int_o^\lambda I_\lambda \, d\lambda$$

where λ is the wave-length at the edge of the screen. Assuming the accuracy of Wien's formula,

$$I = C_1 \lambda^{-5} \epsilon^{-\frac{c^2}{\lambda T}}$$

for the radiation of a black body, which for the wave lengths of the visable spectrum may be regarded as established, we have

$$\int_o^\lambda I_\lambda \, d\lambda = C_1 \int_o^\lambda \lambda^{-5} \epsilon^{-\frac{c^2}{\lambda T}} d\lambda$$

in which, since T is a constant, it is possible to determine the constants by means of a series of observations of L_λ and to obtain the following expression for the distribution of intensities in the spectrum of the Hefner lamp.

$$I_\lambda = 0.0160 \, \lambda^{-5} \epsilon^{-\frac{7.85}{\lambda}}.$$

The intensities given by this equation are represented in the curve (Fig. 5). This curve is very important because by means of it we are enabled to compute the corresponding intensities for any source of light which we have compared spectrophotometrically with the Hefner flame.

In the above equation the constant 7.85 is equal to c^2/T of Wien's formula, and since Paschen and Wanner[1] have found c_2 in the case of a black body to be 14,440, the temperature of the Hefner flame may be computed. Angström finds

[1] Angström, *l. c.*

[2] Tumlirz. *Wied. Ann.*, vol. xxxviii, p. 661.

[1] Paschen and Wanner. *Berliner Sitzungsberichte*, 1899.

this temperature to be 1,830 degrees absolute = 1,557 degrees centigrade, a value which is quite consistent with the temperature of the candle flame computed by Lummer and Pringsheim[1] (1,960 degrees absolute = 1,687 degrees centigrade), with my direct measurements,[2] which gave for the temperature of the candle 1,670 degrees centigrade and with the more recent estimates of G. W. Stewart.[3]

The temperature of the amyl-acetate flame may likewise be estimated by means of Paschen's law, from the position of the maximum of the curve for the distribution of energy in the spectrum.

In the absence of the data to reduce Angström curve, which was plotted with circle readings as abscissæ, to the form necessary to fix the precise wave-length of the maximum, Mr. W. W. Coblentz has had the kindness to repeat these measurements for presentation in this paper. He employed the reflecting

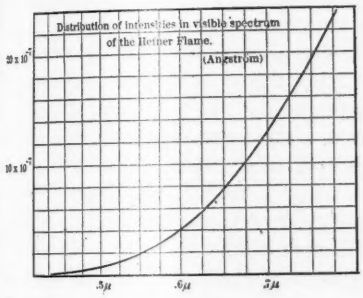


FIG. 5.—DISTRIBUTION OF INTENSITIES IN THE VISIBLE SPECTRUM OF THE HEFNER FLAME.

spectrophotometer, with rock-salt prism and Nichols radiometer, which has been used by him for the past three years in his investigations upon infra-red spectra.

The resulting curve, corrected for slit widths, is shown in Fig. 6. The maximum falls at 1.52 μ and the temperature of the flame therefore, or more strictly the temperature of a black body emitting similar radiation, calculated from Paschen's equation is 1,934 degrees absolute or 1,661 degrees centigrade.

This value is about 100 degrees higher than that obtained by Angström from the relations already described, but, as will be pointed out later, Paschen's equation, using the constant 2,940, gives values, for all flames, considerably above those deduced from direct measurements.

I have considered these results of Angström and others at length because although they do not at present apply immediately to the problems of simple photometry they place at least one source of light in definite relations to our absolute systems of measurement, afford us the data long desired for bringing all other spectrophotometric determinations, by means of comparisons with the Hefner lamp, into the same condition, and afford

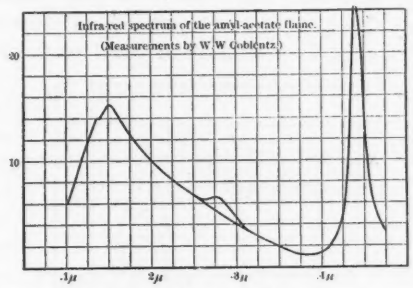


FIG. 6.—INFRA-RED SPECTRUM OF THE AMYL-ACETATE FLAME.

a starting point from which we may be able, ultimately, to define our units of light and of illumination in terms of the absolute system.

PHYSICAL CONSTANTS OF THE ACETYLENE FLAME.

Another fuel of definite composition which, were it possible to control the conditions of combustion, would afford a standard of light superior on account of the intensity and whiteness of the light which it emits to the amyl-acetate flame and to other flames hitherto used in photometry is acetylene. It has thus far been found impossible to devise a reproducible acetylene standard or even to produce a form of burner which will remain of even approximately constant intensity from day to day. Studies of the acetylene flame have, however, brought out very definitely the nature of the difficulties to be overcome and in view of peculiarly desirable qualities of this source of light

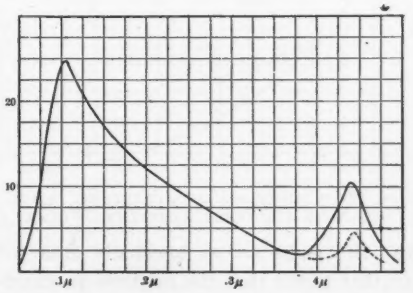


FIG. 7.—ENERGY CURVE OF ACETYLENE FLAME.

for photometric purposes the following summary of results may be of interest.

Acetylene is so rich in carbon that in order to produce a smokeless flame it is necessary to mix with the gas a certain proportion of air. All existing acetylene burners are modifications of the Bunsen type and as the proportion of air increases the flame goes over from the smoky form to that of the non-luminous Bunsen flame passing by intermediate stages through a maximum of luminous intensity. The brightness of the flame and its color depend upon the amount of air which is mixed with the acetylene and small changes in this mixture produce considerable variations both in the intensity and in the quality of the light. Burners designed to be of the same candle-power even when supplied from the same gas holder and operated under conditions as nearly identical as practical as regards gas pressure, etc., exhibit considerable differences in intensity and color and these relative differences vary from time to time to an extent which renders the ordinary form of acetylene burner unsuitable for use in accurate photometry.

The following measurements of the radiant efficiency of the acetylene flame will serve to illustrate the nature of the

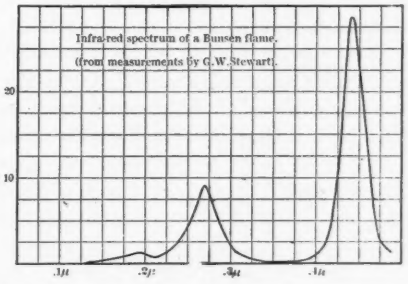


FIG. 8.—INFRA-RED SPECTRUM OF A BUNSEN FLAME.

fluctuations to which flames from burners of the ordinary type are subject.

TABLE.

Radiant efficiency of the acetylene flame.

L/Q = .056 (Angström)[1]
L/Q = .033 (Nichols and Coblentz)[2]
L/Q = .040 (Nichols and Coblentz)
L/Q = .040 (From a curve by G. W. Stewart)

These results with the exception of that of Angström were obtained by plotting the curve of energy for the spectrum of the flame and comparing the luminous with the total area by integration of the same. A study of these curves reveals the nature of the phenomena upon which the fluctuations in intensity and quality in the acetylene flame depend and the chief difficulty which must be overcome in the construction of a strictly reproducible standard of the acetylene type.

The characteristic feature of the energy curve of the acetylene flame is the emission band having its maximum at 4.4 μ, (see Fig. 7). In non-luminous flames of

[1] Lummer and Pringsheim. *Verhandlungen* d. Deutschen Phys. Ges., iii, p. 37, 1901.
[2] Nichols. *Physical Review*, vol. x, p. 248.
[3] Stewart, G. W. *Physical Review*, vol. ix, p. 313.

[1] Angström. *Astrophysical Journal*, xv, p. 223, 1902.
[2] Nichols and Coblentz. *Physical Review*, xvii, p. 267, 1903.

the Bunsen type this band forms the most important part of the infra-red spectrum as may be seen from the curve in Fig. 8 which is reproduced from measurements made by G. W. Stewart.[1] As the air supplied to an acetylene flame increases this band becomes more prominent and the radiant efficiency falls off. The growth of the band adds to the area of the non-luminous portion of the curve, as compared with the total area, and this change in the conditions of combustion affects, as has already been stated, both the quantity and the quality of the light from the flame. That the intensity of CO_2 band in the infra-red spectrum of the acetylene flame fluctuates through a considerable range is shown in Fig. 9, in which measurements of the band in the spectrum of the light from one and the same burner observed on four occasions are plotted.

The curve of October 29 corresponds to conditions of combustion under which the radiant efficiency was 0.033; that of November 8 to an efficiency of 0.040.

Were it possible to burn the proper mixture of acetylene and air in a burner, the dimensions of which like those of the Hefner lamp were sufficiently great to admit of accurate workmanship, there is every reason to suppose that this source of light would show the uniformity desired in a standard. The mixture is, however, violently explosive and in order to keep the flame from striking back the gas orifice must be very small. Not only is it impracticable to make burners with such small openings which will give strictly the same size and intensity of flame, but in a given burner the orifice is subject to partial clogging. The result is a variation in the proportion of acetylene to air and a change in size and intensity of the flame.

Experiments have been made by C. H. Sharp upon the combustion of pure acetylene in a mantle of oxygen using a burner in which a single cylindrical gas orifice was surrounded by an annular opening for the oxygen; an arrangement similar to that of the ordinary blast lamp excepting that the gas is introduced into the centre of the flame. This flame is of extraordinary brilliancy, but its excessive sensitiveness to changes of pressure and its instability renders it altogether unfit for use in photometry. That it is relatively much richer in the blue and violet may be seen from the curve in Fig. 10 which is plotted from Sharp's data (*Physical Review*, vol. ix, p. 179).

[1] Stewart, G. W. *Physical Review*, vol. xiii, p 272, 1901.

L. W. Hartman[1] has made a photometric study of mixtures of acetylene and hydrogen burned in air. When a burner without air vents and consisting simply of a circular orifice through a brass tip was used it was found that the intensity of the flame increased with the percentage of acetylene, and reached a maximum, as shown in Fig. 11, at a point corresponding to a mixture of equal parts of

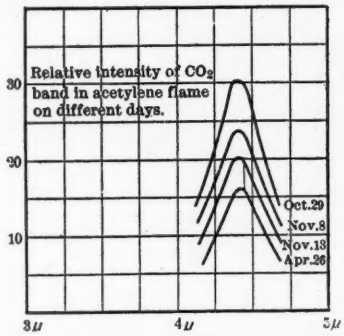


FIG. 9.—INTENSITIES OF CO_2 BAND IN INFRA-RED SPECTRUM OF ACETYLENE FLAME.

the two gases. Further additions of acetylene to the mixture resulted in an increasingly imperfect combustion and a gradual falling off in the brightness of the flame.

The hydrogen-acetylene flame is whiter than that of of pure acetylene burning in air; the former flame being relatively weaker at the red and stronger at the violet end of the spectrum as shown in Fig. 12 which contains a curve of relative intensities plotted from measurements by Hartman. There are certain difficulties connected with the use of an acetylene-hydrogen mixture. The mixed gas can not for example be stored in ordinary gasometers over water because

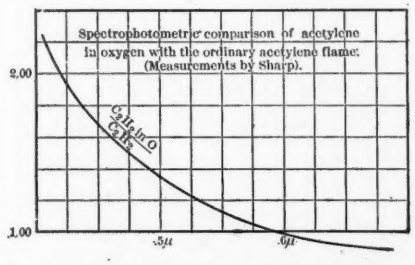


FIG. 10.—COMPARISON OF ACETYLENE IN OXYGEN WITH ORDINARY ACETYLENE FLAME.

the two gases are so unequally absorbed by that liquid that the mixture on standing will rapidly become poorer in acetylene up to the point where to the water is saturated with that gas. Subsequently the mixture will vary in its proportions with changes of pressure as the water with every change of condition absorbs or gives off acetylene to the mixture. This difficulty is not, however, fatal to the use of such a combination provided a mixture of these two gases can be found which is capable of perfect combustion in a burner which is strictly reproducible in its dimensions and construction.

[1] Hartman, L. W. *Physical Review*, vol. ix, p. 176.

With a burner consisting of a single cylindrical jet of one millimetre diameter it is possible without the use of air ducts to produce a quiet steady flame of excellent brightness and color provided the burner be supplied by means of a T from separate gasometers containing hydrogen and acetylene. By igniting the hydrogen first and then turning on the acetylene gradually by means of a proper valve a suitable mixture is readily obtained. The flame, which is of a tall conical form, is perfectly symmetrical and has a well-defined luminous tip. It can be used either with a flame gauge, as in the Hefner lamp, or with a metallic screen similar to that employed in a Harcourt pentane standard. The size of the orifice in such a burner is sufficient to permit of reasonable accuracy in the construction of the standard lamp and the problem of maintaining a constant admixture of the gases may be solved by the use of two similar experimental gas meters, M, M, provided with a rapidly moving index hand for the determination of the rate of flow. By selecting a mixture which corresponds to the crest of Curve A (Fig. 11) the condition of minimum sensitiveness to variations in the proportions of the two gases can be secured. The arrangement proposed is shown diagrammatically in Fig. 13. Only rough preliminary trials with this apparatus have thus far been attempted but there is every reason to believe that with the same attention to details which have been employed in the development of the Hefner lamp an excellent hydrogen-acetylene flame can be secured. The somewhat complicated and cumbersome nature of this apparatus would preclude its employment for general photometric purposes but since a primary standard is required only for the purpose of calibrating incandescent lamps to be used as working standards this objection is of minor importance.

The superiority of the acetylene flame over the Hefner finds graphical expression in Fig. 14 which gives in the usual manner the spectrophotometric ratio throughout the spectrum. The preponderance of the shorter wave-lengths is indeed excessive so far as photometry of ordinary gas and oil flames are concerned, the color difference between such flames and acetylene being about as great on the one side as the difference between them and the Hefner flame is on the other. For use in

comparison with the more modern illuminants of high efficiency such as the Nernst lamp, etc., however, the distribution of color in the acetylene flame is such as to reduce the color difference to a minimum.

Mr. Hartman has also measured the intensity of the ordinary acetylene flame at various pressures. His results, which are given graphically in Fig. 15, show a nearly linear relation.

Spectrophotometric studies indicate for the acetylene flame a temperature considerably above that of the ordinary gas flame.

I have found its temperature by direct measurement to be approximately 2,173 degrees absolute or 1,900 degrees centigrade as against 2,053 degrees absolute = 1,780 degrees centigrade for the ordinary gas flame and 1,943 degrees absolute = 1,670 degrees centigrade for the hottest part of the flame of the common candle. The temperature of the acetylene flame computed by means of Paschen's law from

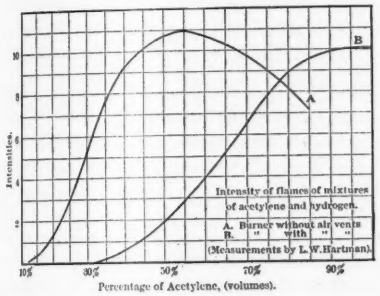


FIG. 11.—INTENSITIES OF FLAMES FOR MIXTURES OF ACETYLENE AND HYDROGEN.

the position of the maximum of the energy curve gives a somewhat higher value. G. W. Stewart[1] finds this maximum to lie at 1.05 μ from which we obtain for the "black" temperature corresponding to the acetylene flame 2,940 degrees absolute or 2,527 degrees centigrade.

The constant A in Paschen's formula has been determined for the ideal "black" body, but the precise relation between the "black" temperature computed by means of it and the actual temperature of the flame is as yet an open question. Stewart in the article just cited has shown that if we adopt the value A = 2,282, the temperatures of the candle, the ordinary gas flame and the acetylene flame computed from the position of the maximum of their respective energy curves agree with the temperatures obtained by direct measurement.

The distribution of intensities in the visible spectrum of the acetylene flame is a matter of great interest to those who apply this sort of light in spectroscopy and

[1] Stewart, G. W. *Physical Review*, vol. xv, p. 311.

spectrophotometric measurements. The observations recorded by Stewart[1] in table i of his paper on the distribution of energy in the acetylene flame, when properly corrected for variations of slit widths, afford the data by means of which to construct the desired curve. It is in-

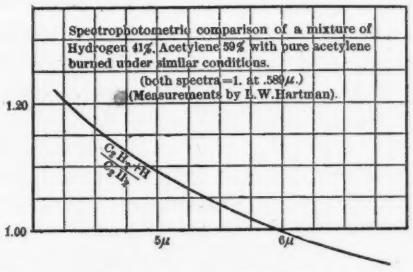


FIG. 12.—COMPARISON OF ACETYLENE MIXTURES AND PURE ACETYLENE.

teresting to compare this curve (see Fig. 16) with that in Fig. 5 which gives us the corresponding data for the Hefner flame as determined by Angström in an entirely different manner.

By making use of the ratio of relative intensities in these two sources of light, given in Fig. 14, and the curve in Fig. 5 it is possible to compute from quite independent data the distribution of intensities in the visible spectrum of the acetylene flame. The points marked with an X in Fig. 16 indicate the value of the ordinates thus obtained in several regions of the spectrum. Since these points lie along the curve plotted from Stewart's measurements we have an admirable check upon the accuracy of these two methods and the spectrophotometric measurements recorded in Fig. 14. This agreement is the more remarkable and satisfactory since measurements made by three different observers are involved.

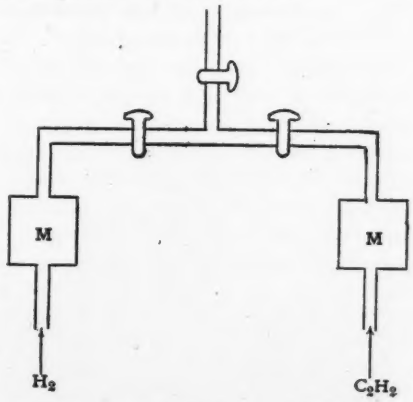


FIG. 13.—MIXING DEVICE FOR HYDROGEN-ACETYLENE FLAME.

The use of an incandescent solid as a primary light standard would at first sight appear to offer many advantages over any possible flame standard, but the difficulties have thus far been insuperable. The three

[1] Stewart, G. W. *Physical Review*, vol. xiii, p. 268.

types of light source available for such a purpose are the incandescent mantle of the Welsbach type, the electric glow lamp, and the Nernst lamp. The difficulties to be considered in the case of the first are three: (1) That of producing mantles of uniform composition; (2) that of maintaining the same at a constant temperature by means of a flame of the Bunsen type; (3) the progressive deterioration in the light-giving power of such mantles as the result of the exposure to high temperatures. Since the performance of an incandescent mantle depends in great measure upon the admixture of certain oxides of the rare earths to the thorium oxide which forms the principal constituent the satisfactory standardization of the material would probably be found impracticable. Burners of the Welsbach type are, moreover, notably sensitive to the well-nigh uncontrollable fluctuations in the character of the heating flame and such mantles show deterioration with time as a result

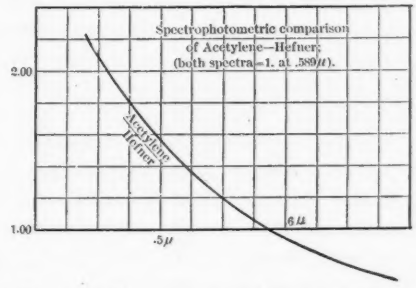


FIG. 14.—COMPARISON OF ACETYLENE AND HEFNER LAMP FLAMES.

of the disintegration of the fabric, whereby the area of the incandescent surface is gradually diminished. The changes due to this cause alone have been estimated to be about fifty per cent during the normal life of such a mantle. The marked change in the color of the light of the incandescent mantle with age is probably due to the fact that this disintegration affects the various components unequally so that the composition of the glowing body is continually changing.

The glow lamp offers a more promising field for development but the makers of such lamps have not as yet been able to furnish a filament which will meet the conditions of reproducibility. The admirable performance of incandescent lamps as calibrated secondary standards however suggests possibilities in the way of the development of a primary standard of this type. Should the use of carbon be found impracticable it is possible that the new iridium lamp may show greater constancy of performance. The use of a filament of the Nernst type as a primary

standard of light is something which has not as yet been seriously considered and it certainly offers a fruitful field for investigation.

Numerous suggestions for a photometric standard have been made of which nothing has been said in this paper. Of these the Violle platinum standard, the use of the light from the crater of the arc and others have been tried and found unmanageable. The use of a phosphorescent surface has been proposed, but even were

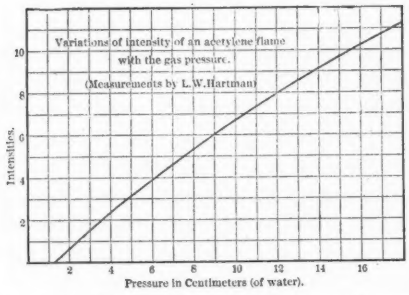

Variations of intensity of an acetylene flame with the gas pressure.
(Measurements by L. W. Hartman)
Intensities.
Pressure in Centimeters (of water).

FIG. 15.—VARIATIONS OF ACETYLENE FLAME WITH DIFFERENT PRESSURES.

such sources of light of sufficient constancy the luminous intensity of all known phosphorescent materials is so feeble that they could be employed only in certain exceptional cases.

While is it probable that the future will see the development of a satisfactory primary standard based upon the electrical heating to incandescence of carbon or of some metallic oxide, the immediate basis for standardization of artificial light sources lies in the use of a primary standard consisting of a flame standard

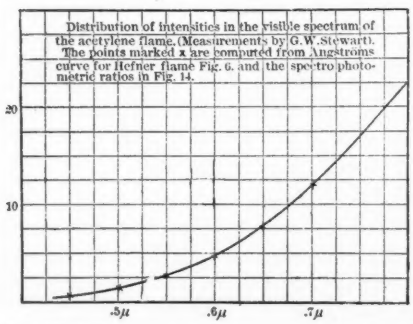

Distribution of intensities in the visible spectrum of the acetylene flame. (Measurements by G. W. Stewart). The points marked x are computed from Angstroms curve for Hefner flame Fig. 6. and the spectro photometric ratios in Fig. 14.
.5μ
.6μ
.7μ

FIG. 16.—DISTRIBUTION OF INTENSITIES IN THE VISIBLE SPECTRUM OF THE ACETYLENE FLAME.

and the preparation of calibrated incandescent lamps as secondary standards of light. Such lamps may in the present state of the art be made to agree with each other with all necessary exactness. While the absolute definable value of such standards can for the present be considered as exact only within the limits of reproducibility of a flame standard such as the Hefner lamp, the actual agreement of the standards existing in those laboratories in which photometric work is based upon the Hefner unit appears to be much closer than the performance of the amyl-acetate lamp would lead us to anticipate.

A set of six sixteen-candle-power lamps, calibrated in New York, were, for example, recently taken abroad for comparison. The average result reported by the Reichsanstalt, according to Dr. Sharp to whom I owe the data, was 15.95 British candles (the ratio 1 Hefner = 0.88 British candle-power being used). When tested in New York after their return they averaged 15.96 candle-power, and subsequent measurements of them at the National Bureau of Standards gave 15.92 candle-power. The performance of the individual lamps may be seen from the following table:

INTENSITY IN BRITISH STANDARD CANDLES OF SIX CALIBRATED INCANDESCENT LAMPS.

	Values at Reichsanstalt. (1 Hefner = 0.88 Cp.) Cp.	Values at Electrical Testing Laboratories After Return. Cp.	Values at National Bureau of Standards. Cp.
	15.87	15.85	15.85
	15.95	16.04	15.90
	15.88	15.99	15.80
	16.00	15.99	15.95
	15.96	15.89	16.00
	16.05	16.01	16.00
Average	15.95	15.96	15.92

Comparison with secondary standards purporting to represent the British standard candle, but not based upon the Hefner unit, gave, it may be added, no such satisfactory agreement.

I present these figures solely for the purpose of substantiating the statement just made, that the calibrated incandescent lamp is capable of very satisfactory performance as a secondary standard. By the constant interchange and comparison of results between the various establishments engaged in the production of such lamps it should be possible to maintain in future the excellent agreement of working standards which appears to have been already attained, and thus to meet the demands of industrial photometry during the period which must elapse before science, through further research, is prepared to offer the practical photometrician something more completely adapted to his needs.

Electric Traction in Russia.

Two rather ambitious schemes for electric traction, says *Engineering* (London), on a large scale have recently been brought before the Electrotechnical Association, of St. Petersburg. The first is no less than the electrification of the Trans-Siberian Railway, a project considered by Count A. F. Lubienski as not only desirable, but necessary. The transportation of passengers and goods on this railway, apart from the traffic due to the war, has developed to such an extent that it will soon become necessary to increase the number of trains. Owing to several circumstances, particularly the lightness of the rails and the insufficiency of water, the existing trains are said to have reached their practical limit of speed; and though the water difficulty might be met by canalization or other means, the relaying of the track would entail an enormous expenditure of money and time. The Count maintains that the most rational and economical way of meeting the case is by the introduction of electric traction on some parts of the line at least. The existing track would be made use of, and the many sharp curves and heavy gradients would not limit the speed of a multiple-unit electric train to the same extent as in the case of a train drawn by a steam locomotive. It is proposed to make use of the rivers and waterfalls along the course of the line for the supply of electric energy, which would be generated at power stations from 100 to 200 kilometres apart, and distributed in both directions to transformer substations at a pressure of 100,000 volts. It must be evident, we think, to the most sanguine of engineers that the scheme outlined above, even if possible, could not be realized in time to meet the present traffic difficulties, though it appears to have been seriously considered as a desirable alternative to the relaying of the track. The second project was brought forward by Mr. G. O. Graftis, and is rather more modest in its scope. He proposes the electrification of the Caucasian railways on the grounds that electric traction is particularly adapted to a mountainous country, and that abundance of power is at hand in the waterfalls of the Caucasus. The large number of rivers and mountain torrents watering the district through which the railway runs, and supplying up to eighty cubic metres of water per second, constitute an ideal source of power, which could be turned to account with little difficulty. As to the expense of constructing a line along the rocky coast of the Black Sea, the speaker adduced figures showing the cost of the Italian Lecco-Sondrio-Chiavenna electric railway and the Viadikavkase steam railway. He estimated that the establishment of central stations and substations equipped with plant for producing three-phase current at 30,000 volts would entail an expense of £1,000,000 above the cost of a steam service. On the other hand, the working expenses of the electric service with the same amount of passengers and goods carried would show an annual saving of £800 per mile as compared with steam. It is also claimed that, as the electric service would admit of heavier gradients, the construction of the permanent way would be cheapened. After the meeting, in consequence of the importance of schemes of this nature to a district well supplied with water power, the Electrotechnical Association appointed a committee to make an exhaustive investigation of the subject.

The Altbach Deizisau Central Station.

By Dr. Alfred Gradewick.

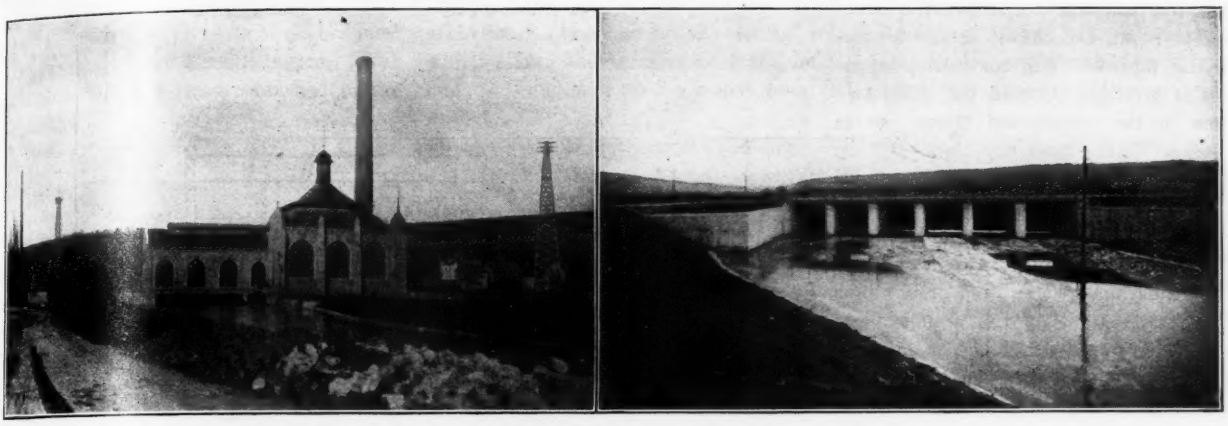
THE electric central station described in this article was installed with a view to supplying power and light to the numerous greater and smaller towns of the Neckar and Fils valleys, in southern Germany, by utilizing the high water head of the Neckar river. Between Plochingen and Esslingen the river follows a winding course, though the distance is only 2.2 kilometres in an air line. The gross head is 4.65 metres and the flow is thirty-three cubic metres of water per second.

A steam engine, having a maximum output of about 1,200 horse-power mounted together with a polyphase generator, which had been exhibited at the Paris Universal Exposition, was purchased, together with a corresponding steam boiler plant, to serve as reserve because of the great fluctuations in the water level. The hydroelectric part of the power station as supplied by the Oerlikon Machine Works, of Oerlikon, near Zürich, is comprised of three turbine sets, each having 120-horse-power effective output.

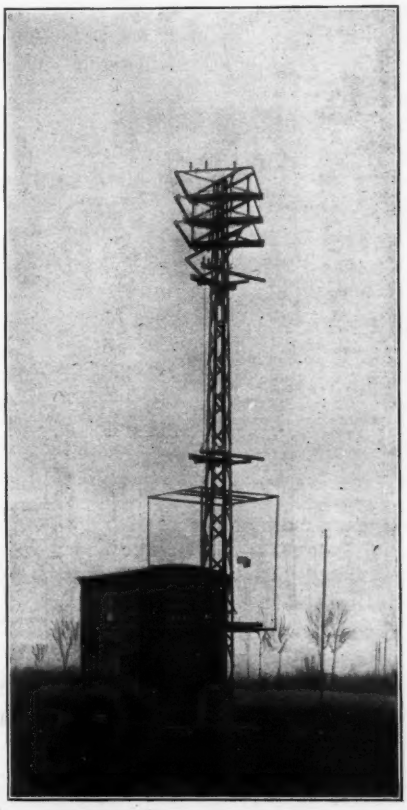
After the installation work had suffered a serious interruption due to a fire in a shed close to the power station, the Oerlikon company undertook the repair of the injured machines and was eventually entrusted with supplying the whole electric equipment of the plant.

Three-phase current with a primary tension of 10,000 volts was adopted, separate transformers effecting the conversion into a 2 by 120-volt three-wire system for lighting and a 230-volt three-phase system for power purposes. In designing the plant, the great distance (nearly thirty-three kilometres) between the places of consumption and the central station had to be allowed for.

A synchronous motor on a 200-kilowatt transformer set has been located in the Göppingen substation and is intended for working as a generator, supplying current to the system in case of a breakdown in the long-distance line. A steam engine set with direct-coupled continuous-current machines is used as a provisional reserve, supplying any necessary additional current as long as the steam dynamo in the central station can be dispensed with.



Power Plant, Altbach-Deizisau Neckar Works, and Forebay and Embankment Canal.



Transformer Station with Aerial Admission of the High-Tension Circuit.

Though the gross head is 4.65 metres and the net head 4.2 metres, there has so far been utilized only a gross head of 3.5 metres, corresponding to a net head of 3.2 metres. The reservoir embankment consists of a concrete weir sixty-seven metres in length and 1.4 metres in height into which two gravel sluices with an aggregate clear width of nine metres are built. The entrance of the channel is at right angles to the river axis and is thirty-six metres in breadth and 1.1 metres in depth. Its bottom, as well as the bed of the Neckar river before the channel entrance, through a breadth of fifteen metres, is covered with concrete. In order to allow of a ready removal of gravel, the Neckar bed was made to lie thirty centimetres below the bottom of the channel entrance; six sluices, each five metres in breadth, draining the latter. Special iron bridges had to be constructed in connection with the embankment. The upper pond channel has a breadth of fifteen metres at the bottom and a depth of two metres, an offset of a breadth of 1.5 metres being arranged one-half metre above the normal water level. The channel is closed on both sides by high-water embankments, intended on one side for carrying off the high water through the channel, and on the other, for utilizing the high water with a view to compensating partially for the water heads lost in the low-water channel, a head of four metres being thus utilized. In front of the central station is arranged an overflow 24.5 metres in length, susceptible of being locked by a sluice in case of moderate high water.

The power-station building, situated on the right bank of the Neckar river, is of a fine design. It covers an area of

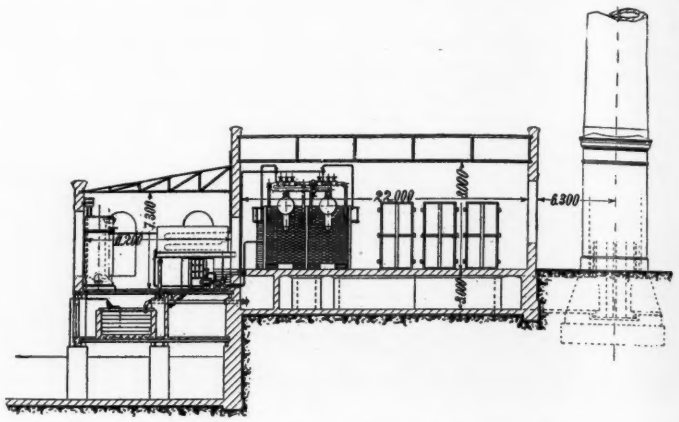
1,300 square metres. The whole building had to be mounted on piers on account of the marshy condition of the ground. The turbine room was built on rock, blasting being necessary when preparing the site.

The four compartments of the power station, namely, the boiler-room, pump-house, hydroelectric compartment, a steam dynamo room, are shown in the accompanying figures. The controlling apparatus is arranged between the latter two rooms in two superposed stories, so as to allow both machine rooms to be perfectly supervised from the one scaffold. By using Falconier glass stones in constructing the windows of the two engine rooms and boiler house, a very efficient heat insulation was ensured, the rooms being ventilated by rotating iron window frames, containing glass stone of the same type. The roof construction is iron, the two engine rooms are covered with tile, and the boiler and pump-houses with corrugated sheet-iron roofing. The chimney is fifty-seven metres in height and 3.5 metres in upper diameter.

The boiler house, situated to the east and designed for five boilers, contains at present two Steinmüller tubular boilers, with 305 square metres of heating surface each. They operate at a pressure of twelve atmospheres, and are fitted with removable superheaters. In the pump-house are located the water-purifying plant, the clean water reservoir, as well as the steam feed pump and the injectors. A hand-driven traveling crane of fifty tons' capacity serves the northern compartment containing the steam dynamo, while the southern room, containing the three hydroelectric units, is served by a five-ton crane, also operated by hand. The rooms are lighted by arc and incandescent lamps.

The three turbines, built by the Fürstlich, Hohenzollernsche Mashienenfabrik, of Immendingen, Germany, are of the Francis type with rotating guiding blades, susceptible of regulation and designed for a minimum amount of water of 10.5 cubic metres and a head of 4.2 metres. A double gate is built in front of each turbine, a common gate being arranged in front of the whole system. The turbines have an output of 400 horse-power at 47.5 revolutions per minute, the motion of the hollow cast-iron turbine shaft being transmitted to a horizontal intermediate shaft, rotating at 215 revolutions per minute by means of a bevel gearing. The generators are connected to the intermediate gearing by means of elastic insulating bands, and are designed for an output of 400 horse-power, at 215 revolutions per minute, with a power-factor of 0.8. The frequency is fifty cycles per second. The tension is 10,500 volts and the load nineteen amperes per phase.

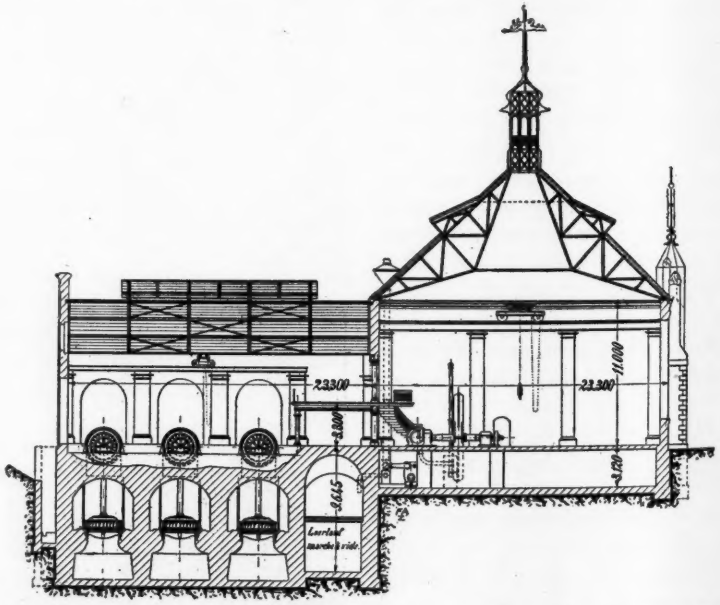
The armatures, 215 metres in bore, have eighty-four slots, each of which contains sixty-three conductors.



Elevation, Showing Steam Auxiliaries.

The latter are three-millimetre wire. The field is formed of twenty-eight coils connected in series, each of which consists of sixty turns of 30 by 2-millimetre copper strip. The field rotor is 2.140-millimetre in diameter. To each generator is coupled an exciter, giving ninety volts and 150 amperes. The efficiency of the generators at full load is ninety-three per cent, and at half load eighty-eight, the difference in voltage between full and no load, with constant excitation, being eight per cent for a power-factor of unity, and eighteen per cent with a power-factor of 0.8. In case of continuous operation at full load, the maximum increase in temperature of any part of the generators will not exceed forty-five degrees above the room temperature.

The steam engine is a horizontal condensing tandem-compound engine of the following dimensions: the diameter of the cylinders is 660 and 1,050 millimetres; the stroke is 1,150 and the speed ninety-four revolutions per minute. The normal output is given as 1,000 horse-power and the efficiency is ninety-two per cent.



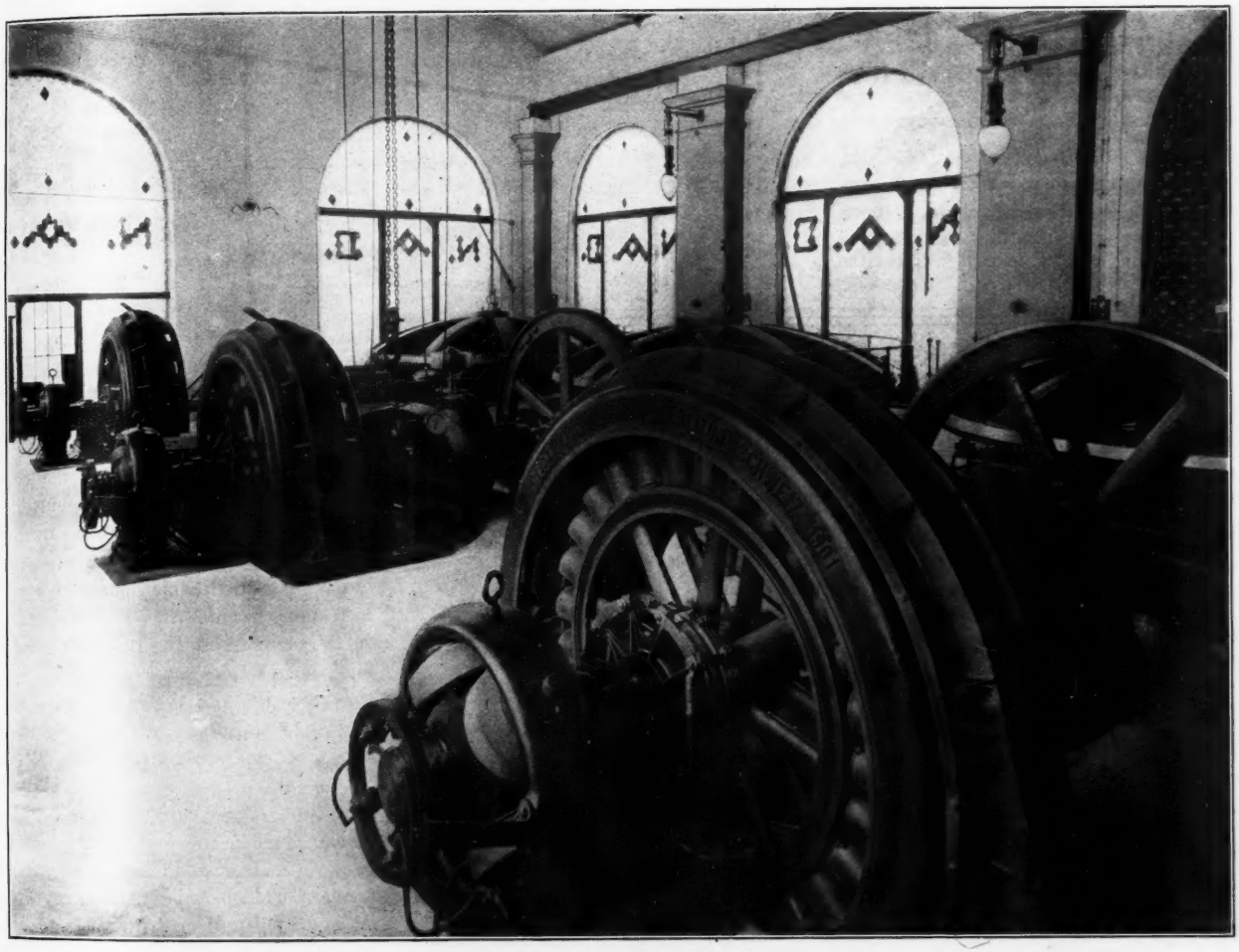
Elevation, Showing Disposition of Turbo-Generators, Switchboard Room and Steam-Driven Generator.

The steam engine drives a dynamo which serves as a reserve and which generates at ninety-four revolutions per minute and a power-factor of 0.85 three-phase currents of fifty periods per second, 10,500 volts and of an intensity of forty-six amperes per phase. The generator is rated at 1,000 horse-power and has an

efficiency of ninety-three per cent with a power-factor of 0.85. The armature is 5.564 metres inner diameter and contains ninety-six coils, consisting each of twenty turns of 4.5-millimetre wire. The slot insulation is four millimetres in thickness, being made with oiled cloth. The sixty-four-pole field-magnet has a diameter of 5.555 metres. The coils consist each of 54.5 turns and are made of edge-wound copper strip, 24 by 3.2 millimetres. The six-pole exciter is direct-connected to the

there are placed a three-pole high-tension pull-switch, three high-tension fuses, a current transformer, a voltmeter, tension transformer, one main-current regulator and one shunt regulator. In the high-tension room there are further installed: one thirty-kilowatt transformer for power, and one twenty-kilowatt transformer for lighting the power station and the village of Altbach, one insulation testing set, which allows the insulation of the long-distance conductor to be tested even in

while the other supports the guiding device for the hand-wheel shaft of the regulating device. The general instrument column supports a voltmeter for measuring the bus-bar tension, a second voltmeter, by means of which the tension of either machine may be measured at will, and a phase-indicator. The collector rails form a circuit from which feeders are branched off to the right and left. The high-tension fuses, as well as the ammeters provided for each phase of the long-distance conductors,



TURBO-GENERATORS IN THE HYDROELECTRIC DEPARTMENT.

generator and generates current at 100 volts and 100 amperes.

The arrangement of the controlling apparatus is shown in the accompanying illustrations. In the lower room, which is closed on all sides, there are placed the high-tension instruments; the controlling platform is placed above and contains the instrument columns, and the levers and hand-wheels for controlling the high-tension instruments. In the high-tension room which is lined with glass, there are arranged five iron supports, one of which is reserved for a steam dynamo, to be installed later on. On each support

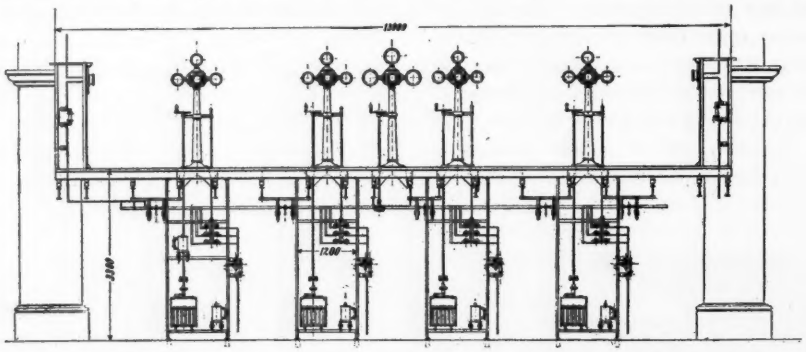
course of operation, and finally several general meters. The collecting bars are made of aluminum and the floor of the high-tension room, readily accessible through a broad central corridor, consists of concrete covered with rubber mats.

The columns designed for the operation of the generators support each an ammeter and a voltmeter for the main current, and an exciter ammeter. The conductors are conveyed to the measuring instruments through the hollow column. To each column are screwed two opposite supports, one of which bears a slide for the hand-wheel, operating the high-tension switch,

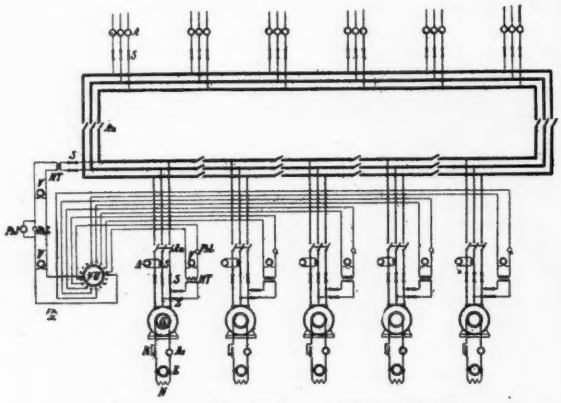
are located in two glass and marble-lined boxes arranged at the front walls of the controlling platform.

Two phases of the system are used for lighting and three phases for power purposes, the tension of the generator being regulated for the two lighting phases. In the engine room there is further a small switchboard containing the switches and fuses of the various distribution lines inside of the central power station. Two long-distance conductors of an aggregate length of 108 kilometres (including all branches) are branched off from the power station. Three of the main conductors

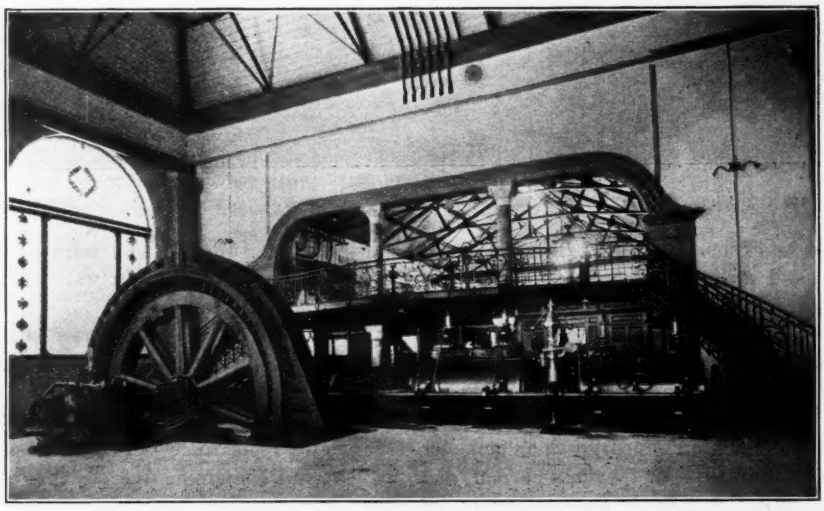
are thirty-five square millimetres and one twenty-five square millimetres. The branch lines are ten square millimetres. From the switchboard platform six cables lead into the distributing tower, to which the long-distance conductors are connected. One of the two long-distance lines leads to Obertürkheim and the other toward Göppingen. Cyanized wood masts, beveled on the top and having a normal length of twelve metres from the ground, are used. The conductors are carried partly on triple bell insulators and partly on delta insulators. In front of the power station, as well as of each transformer cabin and of the Göppingen substation, horn lightning arresters have been placed on the high-tension lines. Where rivers and railway lines are crossed, as well as at all the branching points of the high-tension lines, built-up iron masts have been used instead of wooden masts. To these are fitted, about a man's height above the ground, corrugated-iron cabins containing a small switchboard and high-tension fuses, so as to allow portions of the long-distance lines being switched out at any time, even in course of operation.



ELEVATION, SHOWING ARRANGEMENT OF CONTROLLING STANDS AND REGULATORS.



SCHEME OF SWITCHBOARD CONNECTIONS.



STEAM-DRIVEN DYNAMO ROOM AND SWITCHBOARD GALLERY.

For the operation of these instruments, a small wooden scaffold, resting on four high-tension insulators, has been arranged in front of the cabin.

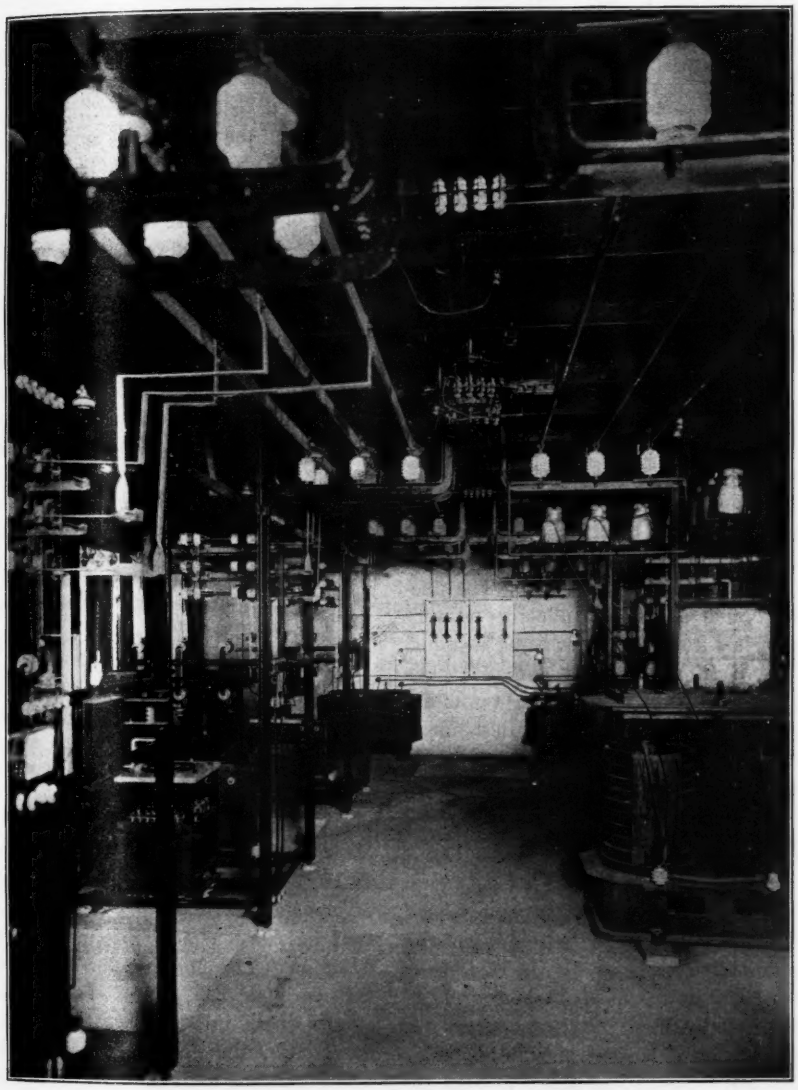
The cabins containing the transformers are made of burnt bricks with roofing of corrugated sheet iron and are divided into three compartments, the greatest of which is intended for receiving the transformers, the two remaining being set apart for locating the high and low-tension switching apparatus. The transformers may be switched off by means of high-tension switches on the high-tension side and on the low-tension side by three-pole switches. For bringing the high-tension conductors and for conveying the low-tension conductors from and to the transformer cabins iron masts are used. If the transformer cabin is installed in building centres, the entrance and exit of the conductors are made underground by means of iron armored cables. The high-tension lines, as well as the low-tension lines, are so designated as to avoid a tension loss of more than three per cent at maximum load.

The tension of the lighting system is 240 volts between the external conductors (three-wire system), that of the power current, 230 volts at the transformer terminals. At the transmission from the aerial to underground cable an iron mast has been located, which supports a small iron house containing the high-tension fuses for disconnecting the cable from the high-tension lines at any time. The cable runs directly into the high-tension room of the substation, which is closed on all sides and contains the high-tension fuses just mentioned, as well as the high-tension fuses of the machine plant, a high-tension switch, the regulating resistance, two voltmeters and one current transformer. The operation handles are located on a switchboard on both sides of which there are only such parts as carry low-tension currents.

In the machine room close to the boiler-room there is, as a reserve, a 250-horse-power reserve steam dynamo supplying continuous current, and a transformer group. There is, however, enough room to allow two additional engine and transformer groups being installed. In a third room is installed a battery of 570-ampere hours' capacity, at 300 volts. The transformer group, alluded to above, comprises a synchronous motor coupled to a continuous-current dynamo with an output of 240 horse-power and working under a tension of 10,500 volts, at fifty periods per second and 500 revolutions per minute. The armature is 900 millimetres in bore,

has thirty-six slots containing eighteen coils, each of which consists of 144 turns of two-millimetre wire; the field wheel is 892 millimetres in diameter, and each of the twelve series-connected field coils has 230 turns of 3.6-millimetre wire.

The continuous-current shunt dynamo, direct-coupled to the motor, gives a current of 550 to 500 amperes at 300 to 330 volts at 500 revolutions per minute. The armature core has a diameter of 854 millimetres and a breadth of 380 millimetres. There are 130 slots of 9 by 36 millimetres, each slot receiving four conductors made from edge-wound copper rods. The field bore is 870 millimetres, the six series-connected field coils consisting each of 1,700 turns of 2.2-millimetre wire.



UNDER THE SWITCHBOARD GALLERY, HIGH-TENSION CONTROLLING APPARATUS.

The construction of the plant was begun in the early part of March in 1901, and it went into operation partly on the first of December of the same year and partly in the fall of 1902.

Economy in Consumption of Current.

A number of questions relating to methods of effective economy in current consumption were addressed to managers of municipal tramways in Great Britain by Mr. P. Fisher, and the gist of these replies was embodied in a paper read at a recent meeting of the British Municipal Tramways Association. The following are his conclusions, as abstracted in the *Electrical Review*, London: the first means of economy referred to, lay in accurate metering at the power station, where energy was purchased from another department. There should be at least three meters in series, the average reading being taken as correct. If one meter showed a variation of three to five per cent, it should be taken out and recalibrated, after which it would serve to check the others. The readings should be supplied to the tramways departments daily, and comparisons be made of the consumption of energy and mileage run, so that any variation could be noted, and investigations made as to the cause.

Serious losses occurred through the line voltage falling below normal, the current increasing to a marked degree. It was suggested that the overhead work should be cross-bonded, so as to utilize the current-carrying capacity of both wires, and this had been done in some cases. The objection was that when a fault arose on one line, both lines were put out of service.

Last year Mr. Spencer (Bradford) pointed out the economy to be effected by rapid acceleration. The reports of managers on this matter were conflicting. The author had made experiments to determine the amount of the saving, and found that with more rapid acceleration, a marked economy could be made, but did not suggest that the method was desirable in the interests of the equipment or the passengers.

The energy used by different drivers varied widely, and the author found that it was of the first importance to have men carefully and thoroughly trained, and well kept up to the mark. The system introduced at Blackburn by Mr. Giles provided a bonus to the men of one shilling a week for each tenth of a unit per car-mile reduction in the energy consumed, thus giving the men a pecuniary interest in economy. The employment of inspectors to instruct drivers and to check waste was fully justified, and the efficiency of the men raised thereby.

Meters on cars were not entirely satisfactory, but had been adopted on many systems with good results.

The condition of the rails in foggy weather, and when covered with greasy deposit, had a decided influence on the consumption of energy, and it was agreed that to keep the rails in a clean condition was highly important. The rails must be cleaned by mechanical means or by washing, and the author had adopted a device which he first saw in Bradford, by which a continuous flow of water from the town mains was used when the rails were greasy. The water ran down gradients in the grooves, and the car-wheels sprinkled it over the top of the rails, cleaning them thoroughly. Drain connections were provided at the lower parts of the city to carry off the water to the sewers.

The energy used on bogie cars exceeded that on single-truck cars by about twenty-seven per cent in one case, and it had been found that economy was obtained by converting bogie to four-wheel cars. On a line with a rise of 255 feet in one and one-half miles, a bogie car on maximum traction trucks, seating fifty-nine passengers, required almost forty per cent more energy than a single-truck car seating fifty-one passengers, though the line, having many curves, was favorable to the former. It was satisfactory to observe that radial trucks with four wheels were being introduced.

Reviews of Current Engineering and Scientific Literature.

Electricity in Warships.

In this article the electrical equipment of the Césarevitch, a Russian battleship of 12,000 tons displacement, is described. One of the important applications of the electric motor on this vessel is that of directing the large guns. The movable turrets weigh about 300 tons. They rest on rollers, and are operated by means of a central tube which serves, at the same time, for communicating with the ammunition rooms. This tube is turned by means of two motors, each acting through a worm and wheel. The fields of these motors are connected permanently across the supply circuit. The two armatures are connected in series, and in series with them is a resistance. These motors are controlled by the gun captain in the turret, who, by means of a small controller, actuates relays in the motor armature circuit. Turning the controller handle to the right or left puts the turret in motion. Placing it in the central position short-circuits the motor armatures, bringing them instantly to rest. The vertical movement of the gun is controlled by a horizontal lever attached to the side of the gun carriage. This lever controls the movement of a small motor. Placing this lever in any position will cause the gun to be trained until its axis comes parallel to that of the lever.—*Translated and abstracted from La Revue Pratique de l'Electricite (Paris), September* 20.

South African Electrical Industry.

The electrical industry has developed rapidly in South Africa since the recent war. At present all towns with more than 1,000 inhabitants either have their electric plants or are arranging for them. In this colony there are no such restrictive regulations in force as at present existing in England. In the matter of low-pressure distribution, overhead lines are used freely, a condition which enables the smallest towns to adopt an electrical supply. Johannesburg is supplied by an overhead line carried for twenty-two miles from Brakpan, at a pressure of 12,000 volts. In Durban there are some sixty miles of low-pressure line supplying the residential portion. Johannesburg has recently placed orders with English firms for $1,700,000 worth of electrical apparatus. The harbor authorities at the various ports are adding to their dock facilities as rapidly as possible, and are, in many cases, adopting electric cranes and transporters. The northern section of the colony is the only one where water power is available for power purposes. Although there are other points where falls exist, the supply is too irregular to admit of development. In Natal there are at present two water-power transmission plants. In British Central Africa there is a small water-power plant at Zomba. A concession has recently been obtained for lighting Nairobi, in British East Africa, by water power. In the northern parts of the Transvaal, the Transvaal gold-mining shed at Lydenburg has a three-phase water-power plant, and in the Baberton district, Pigs Peak, Moodies and the Sheda mines are similarly equipped. In Cape Colony a water-power plant has recently been installed for the Cape Orchard Company, at Hex river. The development of the mining industry in the Rand and Rhodesia will cause a great demand for electrical apparatus, to be installed in large central stations. Electric haulage has not yet been put to a large use, but rapid development may be expected. The telegraph and telephone industry is very active just now, new lines being installed in the territories recently annexed. The telephone systems of the older towns are being remodeled after the latest ideas. Trunk lines are being run which will put Johannesburg in connection with the coast towns.—*Abstracted from the Electrical Review (London), September* 30.

Electric Railway Braking.

In this section of an article discussing braking of electric cars, Mr. E. H. Dewson describes the straight air-brake equipment as frequently used. In this system the reservoir should be large enough to operate the brake three or four times without the pressure falling more than twelve or fifteen pounds. The air from the reservoir is supplied directly to the brake cylinder through a valve. The pressure in the reservoir is kept approximately constant by an automatic governor, which controls the small motor-driven compressor. The governor ordinarily starts the compressor if the pressure falls to fifty pounds. It stops it when the pressure in the reservoir has reached sixty-five pounds. When installing the system it is important to place a switch in the compressor motor circuit at each platform, so that the motor may be stopped if the governor fails to work. When whistles, pneumatic sanders and other devices operated by compressed air are to be used, these must be considered when deciding upon the size of compressor and reservoir. Frequently it is found that the whistles alone use as much air as is required by the brakes. The advantage of the straight air brake lies in its directness and simplicity and in the fact that it requires less skill to make an exact stop than with an automatic air brake. Its greatest disadvantage is due to the fact that, in the event of a break in the piping or in the hose connections between the cars (if operated on a train), the motorman is left with nothing but the hand-brake on which to depend. Another disadvantage, which is apparent in operating in trains, is that the brakes of the different cars do not act simultaneously, due to the frictional resistance of the train pipe. This causes a disagreeable, and often dangerous, bumping and jerking of the cars.—*Abstracted from the Electric Club Journal (Pittsburg), October.*

The Puyallup River Water-Power Development.

The Puyallup river station was built to supply electric power to Seattle and Tacoma. The water is carried by a flume ten miles long to a reservoir on a high plateau, and thence discharged, by means of steel pipes, against Pelton wheels in the power-house, 872 feet below. The plans contemplate an initial installation of 20,000 horse-power, with an ultimate development of 40,000. The power-house is of massive concrete, brick and steel construction. The building for eight units will be 100 feet by 266 feet, divided longitudinally into two parts—a generator house and a transformer switching house. The generating units are arranged parallel to and along the river side of the building. The transformers are grouped in isolated rooms of concrete in the basement of the switch house. The switching apparatus and the wiring are placed in compartments overhead. Each unit consists of two overhung Pelton water-wheels ten feet six inches in diameter, one mounted on each end of the shaft of each 5,000-horse-power, two-bearing generator. The nozzles are of the needle type, arranged for automatic deflection by means of Lombard governors. The wheels are

started, stopped and adjusted for speed from the switchboard. There are at present four revolving-field, 3,500-kilowatt generators, wound for three-phase current, 2,300 volts, sixty cycles per second. There are two exciters, each capable of exciting six generators. There are two sets of 2,300-volt bus-bars. Between these and the generators there are disconnecting switches. There is one set of high-tension bus-bars, divided into three sections by sectionalizing switches. Between the high-tension bus-bars and each bank of transformers are two sets of disconnecting switches and one triple-pole, 6,000-volt, 400-ampere, motor-operated oil switch; one set of disconnecting switches being on each side of the oil switch. From the power-house two parallel transmission lines run a distance of twenty-two miles to Bluffs. From here one line runs to Seattle, and one to Tacoma. That running to Seattle is operated at present at 27,000 volts, but it has been designed for double this voltage. The insulators are dark brown glazed porcelain, mounted on one line on galvanized malleable iron hollow cast pins. On the other line the pins are of the same shape, but turned from Eucalyptus wood treated with linseed oil. The insulators have a broad umbrella-shaped top fourteen inches in diameter, and withstand a potential of 90,000 volts before arcing over under a rain test. At the substations the voltage is lowered to 2,300, at which pressure it is distributed throughout the town. It is also converted, by means of rotary transformers, into direct current for the railways. The substations contain a bank of transformers, stepping down from 25,000 volts, three-phase, to 2,300 volts, two-phase; and a 300-kilowatt induction motor-generator set, together with a storage battery having a rating of 384 kilowatts on the hour basis.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), October.*

The Newcastle-upon-Tyne Electric Supply Company.

The Newcastle-upon-Tyne (England) Electric Supply Company commenced operations in 1891. This company has been very successful, and at present is one of the largest in England. In this article Mr. T. H. Minshall describes its stages of development, which are illustrated by three typical power-houses. The first, located at Pandon Dene, was built fifteen years ago, and acquired by the company. It then consisted of two 200-horse-power engines, each driving a 100-horse-power single-phase alternator, giving 2,100 volts. From the commencement of operations the local increased until it reached 1,600 horse-power in 1900, when it was found necessary to increase the supply by building a second station. The site selected for this was Neptune Bank, where a station was built and put into service in the fall of 1900. This station was designed to supply three-phase current at a pressure of 5,500 volts, forty cycles. The first generators installed were driven by marine engines. That added afterward was driven by a steam turbine. The present equipment consists of one seventy-five and two 300-horse-power direct-current generators, and four 1,200-horse-power three-phase generators, with one 3,000-horse-power Parsons three-phase turbo-alternator. At this station the cellular type of switch gear was adopted. In 1902 it became evident that it would be necessary to reenforce the Neptune station by a third, and the Carville power-house was erected, the station going into operation last July. The important features of this station are its division into practically independent stations; the adoption of steam turbines; the use of marine-type water-tube boilers and electrically operated oil-break switches. Steam turbines were adopted because the performance of the turbine at the Neptune Bank station had been most satisfactory. The present equipment of the station consists of two 3,000-horse-power turbo-alternators. Tests upon these units show a steam consumption of eleven pounds per electrical horse-power-hour at the most economical load. This is with a steam pressure of 200 pounds and 150 degrees Fahrenheit superheat. The original distributing system consisted of concentric, lead-covered, armored cables laid in pipes. This has been replaced by a three-wire, direct-current system. The Pandon Dene station is now used as a substation only. The other two supply power to twenty-nine other substations. This system supplies about 7,500 horse-power to manufacturers, 2,000 to small motors, 7,000 in lighting, 8,500 for traction, and 2,000 in bulk.—*Abstracted from the Electrical Magazine (London), September 15.*

The Theory of Accumulators.

Of the many explanations of the action going on in the lead accumulator, none seems to M. Paul Bary to be entirely satisfactory, and he here gives some of his own ideas, which resulted from a careful study of the behavior of lead and other metals when undergoing electrolysis. Metals forming two stable oxides behave in two ways, depending upon the salt in solution. If this be the higher oxide, the metal is deposited at the cathode and the acid radical appears at the anode. If the lower salt be electrolyzed, the metal appears at the cathode, but a higher oxide of the metal is deposited on the anode. The author believes that this law applies to the electrolysis of lead sulphate, and that a higher sulphate exists. This would be in agreement with the theory of the accumulator, as stated by Gladstone and Tribe, which is held to be the only theory giving a satisfactory explanation of the energy changes. The action is then supposed to be that of the decomposition by the electric current of the lead sulphate which is in solution, producing a higher oxide of the metal at the anode, and depositing the metal at the cathode. To test whether it was the lead sulphate in solution which was acted upon by the current, solutions of this salt in sulphate of soda and other solvents were made, in every case the peroxide and the metal being deposited. Next a sample of the electrolyte was taken from a cell after charge. Treating this with alcohol threw down a precipitate of lead sulphate. When drawing a sample of the electrolyte from a cell during charge, the sample being taken from the neighborhood of the plate, this gave no precipitate when treated in the same way, showing that lead sulphate was not present at the point from which the sample was drawn; it apparently having been decomposed by the current. If this explanation of the action of the accumulator is correct, it also explains the loss of capacity when discharging at a heavy rate, this being due to the slight solubility of the lead sulphate, it not going into the solution fast enough. Any material added to the electrolyte which increases the solubility of the lead sulphate should increase the capacity for heavy rates of discharge. This was found to be the case. Adding a little sulphate of soda increased the capacity fifteen per cent in two tests.—*Translated and abstracted from Éclairage Électrique (Paris), September 3.*

Electric Traction in Belfast, Ireland.

United States Consul Edward Harvey, at Belfast, Ireland, reports that plans are now being drawn up for converting the present horse-car system of that city to electricity. It is estimated that the cost would be over $4,000,000. There are now forty miles of rail in and about Belfast, and ten or twelve miles of new lines will be laid. Over 100 new cars are to be ordered.

THE DEVELOPMENT OF ELECTRIC TRACTION.

AN ABSTRACT OF THE ADDRESS BY PRESIDENT W. CARYL ELY AT THE CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION, ST. LOUIS, OCTOBER 12, 1904.

The Street Railway Association year now growing to its close has witnessed many things of supreme interest to the electric railroad world. During the present year the New York Central & Hudson River Railroad Company has matured its plans for the electrification of its great trunk lines entering the city of New York and the lines radiating therefrom for a distance of thirty-five miles; the Pennsylvania Railroad has determined upon the electrification of that section of its line which will enter the city of New York in two great subterranean tunnels underneath the waters of the Hudson river; the Schenectady Railway Company has begun the operation of cars propelled by means of single-phase alternating-current motors in regular service carrying passengers, and the General Electric Company at the recent meeting of the New York State Street Railway Association, at Utica, has exhibited in practical operation a car propelled in part over the tracks of a city system by direct current and in part over connecting interurban lines with the single-phase alternating current. Purchases of street and interurban electric railway systems of considerable magnitude have been made by the New York Central & Hudson River Railroad Company in the central portion of the state of New York, and this great corporation has announced its intention of electrifying a portion of its West Shore Railroad tracks in connection with the street and interurban railway systems thus acquired.

The electrification of the Manhattan Elevated Railway system, which was finally completed in June, 1903, in which month the last steam train was taken off, has during the past year enabled a direct comparison to be made between the operation of the system by electricity and steam. It has been determined that the substitution of electricity has increased the carrying capacity of the road thirty-three per cent, as indicated by the actual increase in car mileage; the passenger traffic has been increased thirty per cent; the operating expenses have decreased from fifty-five per cent of the gross receipts in 1901 to forty-five per cent in 1903, and all obnoxious vapors, smoke, steam and cinders incidental to steam locomotive operation have been eliminated from the streets traversed by the railways of the system. The wisdom of the enormous expenditure of money necessary to make the change has been fully demonstrated by the benefits which have proved not only to the people of the city, but to the intelligent management which at such great cost made the change. This great system which carries nearly a million of passengers each day has been leased to the Interborough Rapid Transit Company, which during the past four years has been engaged in constructing underneath the city of New York a vast system of subways, which is now completed and a portion of which will be put in operation during this present month. This system comprises fifteen miles of subway and five miles of elevated structure, providing for sixty-three miles of single track to be electrically operated by the protected third-rail system and trains operated by the multiple system of train control. But little over four years have been occupied in the construction of this great work, and when the difficulties encountered beneath the streets and the buildings of the great metropolis are taken into consideration in connection with the magnitude of the work itself, it is to be doubted if the record made in this construction has ever been equaled in the history of engineering or construction achievements. On Wednesday last it was my privilege, upon the invitation of the general manager and the general superintendent of the Interborough company, to join a large party of railway men in the inspection of that portion of the subway upon which trains are now being operated preparatory to the formal opening to the public during the latter part of this month. The ventilation of the subway is well nigh perfect and all parts of the work, including the railroad and its equipment, leave nothing to be desired. Being practically familiar to some extent with the underground railways of London and Paris, I was enabled to make direct comparison between them and this latest of modern subways. It is gratifying to be able to state that the points of superiority in this newest work are many and so self-evident that they may be at once detected not only by the skilled railway manager or engineer, but by the every-day traveler. The benefits that are to flow from this great system of underground railways to the varied interests of the inhabitants of the great metropolitan city and those who do business within its boundaries are difficult of adequate conception. Our train left the City Hall station at the Brooklyn bridge and in less than seventeen minutes we were at One Hundred and Forty-sixth street, a distance of about nine miles, and impossible of accomplishment in any other way in less than an hour or an hour and a half. The speed of the train at some points was nearly a mile a minute, but so smooth was the track and so perfect its grades and alignment that the great speed was practically unnoticed and almost before one had realized that we were off on the journey the arrival at its end was announced. It is almost impossible to realize what the work alluded to above means to the city and state of New York and that portion of New Jersey bounding the great metropolitan city. It is estimated that the city and its neighboring cities that ought to be considered as within the metropolitan area contain about 4,500,000 people. The growth of the city and the metropolitan district has been very much hampered in the past by the inadequate facilities of transportation between the homes of the people and their places of work, business and recreation, and the discomforts of life owing to the insufficiency and inefficiency of transportation facilities have been so great as to constitute a real hardship to those who were forced to dwell within the area described. But great as will be the addition to the comfort and convenience of the people caused by the additional railroad trackage included in these works, after all the most inestimable benefits flow from the utilization of the subtle element electricity in connection with the works. By means of it ventilation is secured in the subterranean tunnels and the foul air is made sweet; the cars and the subway are lighted and heated by it, and the dark places wherein danger lurked when the operation was by steam are made light and safe; cleanliness is made possible everywhere and the highest degree of comfort and convenience that could be dreamed of seems to have at last been attained. It is by the mastery and the utilization of this same agent that you in the operation of surface street and interurban railways have in these later days wrought a grand transformation. You are so familiar with all these things that I fear lest I be guilty of over-description in what I have said concerning them, but I am bound to congratulate you upon having given so good an account of your stewardship of this great modern agency of motive power, heat and light in its application to your business that those who have been contending with the great problems of steam railroad transportation have found it both advantageous

and necessary to take it up and still further exploit and use it for the benefit of mankind. In a paper recently presented at the International Electrical Congress held at this exposition, Mr. Frank J. Sprague, writing of the history and development of electric railways, in which he has played such an important part, says:

"What the electric railway has done may only briefly be referred to here, but the writer may be permitted to repeat the substance of remarks written some nine years ago, for it has become a most potent factor in our modern life, and left its imprint in the indelible stamp of commercial supremacy. It has given us better paved streets, greater cleanliness, more perfect tracks and luxurious, well-lighted and well-ventilated cars; and with the higher speeds it has made possible the extension of the taxable and habitable areas of towns and cities in a much greater ratio than is represented by the increase of speed.

"It has released from drudgery tens of thousands of animals, and increased the morale of transportation employés. It has given employment to an army of men and hundreds of millions of capital. It has improved and extended the telephone service by forcing the abandonment of ground circuits. It has built up communities, shortened the time between home and business, made neighbors of rural communities and welded together cities and their suburbs."

Will it replace the steam locomotive? Perhaps the best answer is that its future is not in the wholesale destruction of existing great systems. It is in the development of a field of its own, with recognized limitations but of vast possibilities. It will fill that field to the practical exclusion of all other methods of transmitting energy; it will operate all street railway systems and elevated and underground roads; it will prove a valuable auxiliary to trunk systems, but it has not yet sounded the death-knell of the locomotive any more than the dynamo has that of the stationary steam engine. Each has its own legitimate field which will play its proper part in the needs of all civilization.

But its work within the sphere to which it is at present confined has brought about social and economical results which are being constantly more and more forcibly impressed upon the minds of the observers of conditions of growth and settlement in this country. A writer in the *Yale Review* recently pointed out the results attendant upon the electrification of the street railways and the construction of the interurban railways, which have been connecting up and binding together the cities and populous places throughout the country, and in the *New York Sun* in an able editorial reviewing the article mentioned, remarked that the whole country was becoming urban, and humorously stated that the "hayseed" was disappearing from the land. Present results are really wonderful. It is difficult to correctly divine the future, or to make any prognostication concerning the ultimate social and economic results that may flow from the elimination of the line between the city and country. We can only judge of the future by the past. It is safe to say that this latest and most beneficent of servants given by nature to man will continue to be utilized for his betterment in a ratio that will constantly increase with the passing of time. With the ever-growing intelligence of the people concerning this great modern agency, and the increased recognition of the beneficial results to accrue to the public from an intelligent cooperation by it with your efforts, you will find your burdens lighten as time goes on, until finally there will come a period when with mutual recognition of the duties and obligations which each owe to the other you will secure the widest radius of beneficial action and the maximum of pecuniary results and public recognition.

A careful inspection of the proceedings of the conventions of the last few years reveals the fact that most of the time of each convention has been occupied with the reading and discussion of papers embracing subjects which for the most part relate to the small technicalities of the business, nearly all of which might have been profitably committed to proper auxiliary and subsidiary organizations. Broad fields of cooperative effort in the most important lines of our work have remained almost untouched. It becomes immediately apparent upon investigation and discussion of the situation that we might profitably enter upon the discussion of the greater questions affecting our welfare. The confusion of laws throughout the country affecting our corporations is a matter to which we might well devote attention. There are also such great questions as taxation; municipal ownership of street railways; franchise rights and obligations; statutory laws affecting our class of companies; municipal laws and ordinances, and other questions of importance to which your minds will readily refer. The collection and preservation of data tending to throw light upon the problems of great importance that confront us is also a matter deserving of attention, and in this regard it would seem that through the medium of the secretary's office and of appropriate standing committees an invaluable collection of data could be made and permanently preserved in such form as to be conveniently accessible to any member of the association upon merely making request of the secretary. If the work of the secretary's office should be made continuous there would thus grow up in time a vast repository of valuable statistical and historical information, readily available as matter of right to every member. This branch of the work alone, if properly prosecuted, would render membership in this association so valuable that it is difficult to understand how any street railway corporation would feel justified in remaining outside of this association. It is our duty to keep in step with the changes in conditions that confront and surround us; we must be in synchronism with the spirit of things; we must not hesitate to make necessary and beneficial changes, nor should we be deterred by our consideration of the past.

"Upon the stepping stones of our dead selves we rise to better things."

It is undeniable that notwithstanding the fact that the intelligent and broad-minded policies that to-day characterize the operation of the great properties represented in this association, and notwithstanding the fact that inestimable advantages have been and are being thereby conferred upon the entire public within your individual spheres of action, there exists to-day a tremendous amount of misunderstanding of your labors and the effect thereof upon individuals and communities. Intelligence must replace ignorance; darkness must give way to the light. There are to-day no matters or things really in difference between yourselves on the one hand, and the public on the other. With right understanding there will come about perfect accord. The remnants of old suspicions founded upon misconception and misunderstanding must be swept away. It is only by a general diffusion of information concerning our properties and our work that public appreciation may be obtained. Let us bury all questions of prerogative, precedence and personal advantage and unite in a vigorous and persistent effort to bring out of present conditions such a state of organization and work as will not only meet with the intelligent and hearty approval of all those comprised in our different organizations, but will also put us in closer touch with the public whom we serve, and tend to the creation of such a condition of things as will enable us best to work out legitimate ends and purposes.

Steam Turbines and Internal Combustion Engines.

A Symposium of Ideas Brought Out in a Recent Discussion.

AT THE recent convention of the American Street Railway Association several interesting papers were read, bearing on the modern development of the steam turbine and internal combustion engine. The reading of these papers furnished some discussion; a presentation of the salient features will no doubt be of value to all engineers. The paper by Richard H. Rice on "Steam Turbines" was discussed at length.

Mr. Rice sketched briefly the application of the steam turbine as a prime mover for small generating units. Since high speeds are unavoidable, extreme care must be taken in balancing the rotating parts. The General Electric Company makes units rated at one and one-half, fifteen and twenty-five kilowatts. These operate non-condensing, and there is but one stage in the turbine. The fifteen-kilowatt set is used for train-lighting service—sometimes placed in the baggage car and sometimes on the locomotive. All of these smaller units are governed by a throttle valve actuated directly by the governor. Curves were shown demonstrating the performance of these machines. All sizes of seventy-five kilowatts and under are direct-current units. The steam turbine is used principally for driving electric generators, but some application has been made in driving other forms of apparatus. This problem involves the finding of a satisfactory method of reducing the speed. It is thought that this has now been accomplished.

In the discussion which followed, Mr. W. H. Abbott, of Cleveland, asked Mr. Rice to give a further description of the high-speed commutators, and whether they run in oil or are submerged.

Mr. Rice replied that the commutators run dry, with lubricated brushes, and the commutator bars are well supported by nickel steel rings shrunk on to the outside, over the insulation. The commutator bars of the larger size are turned off in place after the shaft is put in the bearings.

Mr. Abbott enquired if they were carbon brushes, to which Mr. Rice replied they were.

Mr. C. O. Mailloux, of New York, said that he would be glad to give the results of some observations which he had made in an extended tour in Europe last summer in which the investigation of steam turbines under various conditions was one of the principal objects he had in view. He was under the impression at the outset that steam turbines were not very suitable for use in driving direct-current generators, but he was pleased to say he had seen numerous instances of direct-current dynamos which are being driven at rather high speeds in Europe. The largest unit he had seen was a 250-kilowatt running at 2,500 revolutions. He had seen several small sizes running at 3,000 and 4,000 revolutions. There seemed to be no difficulty, at least no difficulty which is not likely to be overcome, in the operation of such machines. The brushes are generally carbon, although in some cases he had seen metal brushes of the Boudreaux type used with satisfaction. The tendency, however, is to prefer carbon brushes wherever they can be used, because the Boudreaux brush requires a much better electrical design than the carbon brush in order to get sparkless and suitable commutation. The general practice is to make the commutator very strong, using nickel steel bands around it, or similar bands of very ample proportions. He had heard of but a few cases where sparking had given trouble, and it had been due in nearly every instance to unbalancing; where the armature is not properly balanced there is a slight chattering, which, though not visible to the eye, is yet sufficient to keep the brushes dancing on the commutator and thus soon become rough and give trouble. He was glad to see a line of small turbines developed in this country, as they have already been developed in Europe. He had ordered two small turbines in Europe for direct-current work, of fifteen kilowatts each, because he was not then satisfied he could get in this country direct-driven turbines that would answer the purpose. He was glad to see the General Electric Company developing a line of small turbines that can be driven direct. He meant by that, turbines which do not require gears. He had had some experience with small turbines in which the speed is reduced through a gear, but found while they did the work, they are necessarily more delicate and not so satisfactory as one which does away with the gear. One of the uses to which small turbines are being put in Europe is that of driving pumps for boiler feed. He knew of several instances where direct-driven centrifugal pumps working under high pressures are being used very successfully as boiler-feed pumps. They have great advantages, because they have no reciprocating motion, the feed is absolutely steady. In cases where the exhaust steam is used for feed-water heating, it will be realized that the economy of the system is not of great importance, so that while it is in the abstract desirable to have a small turbine unit which gives as high an economy as possible, yet for many applications, such as for auxiliaries in a power station, in many cases it would be rather desirable to have the auxiliaries consume a great deal of steam than the reverse, because in many modern power stations to-day it is becoming a problem to be able to get sufficient feed water without using live steam and without using economizers, which many are not inclined to favor.

Mr. Abbott enquired if Mr. Maillou had found that there was any great danger from water in the steam in using the turbine, water carried with the steam, even if the steam may be superheated?

Mr. Mailloux said he had heard of no cases of such trouble, although he had seen cases where turbines were operated at very low pressure. He visited one installation in a mine where a 250-kilowatt turbine is operated from the exhaust steam of a hoisting engine, which steam was collected in a device called a steam accumulator, so that a pressure of a few pounds is available. The turbine is run condensing, and enough power can be obtained from the exhaust of a 1,500-horse-power engine by the low-pressure turbine to drive a 250-kilowatt generator. The steam is naturally not very dry, but although the plant had been running for some two years, there was no record of any difficulty whatever. He had heard of no trouble being experienced with steam turbines from water. He could hardly understand how water could be present in superheated steam, because the idea of superheat itself would imply that there can not be any water there, because any water would become saturated steam at the expense of superheat.

Mr. S. M. Hopkins, of Columbus, Ohio, said that in Columbus a 500-kilowatt turbine was installed and had to be started up temporarily to take steam from a long line. Superheat is used and, therefore, no provision was made to drain the lines, depending upon the superheat to take up such condensation as would occur in the

line. The turbine was connected practically on the end of the line, and also an exciter engine, the turbine spoken of being used principally for lighting work. They would find a large amount of water condensed in the pipe, not being drained properly; in fact, it was almost impossible to start the exciter engine. No trouble was experienced after starting the turbine up with a large amount of water going through. High pressure is used, and in starting with high pressure large gulps of water came out of the exhaust without any apparent injuring or jarring of the turbine in running. He further said that in the last six months he had done some practical work on two 500-kilowatt turbines, installed in a steam station and taking steam from the steam boilers, and that practically under the same conditions were two Green-Wheelock tandem engines, with a cylinder ratio of sixty-one, connected to two 500-kilowatt direct-connected generators. In order to get at the real comparative commercial value of an engine unit of similar size, working under the same conditions of superheat as the turbine, quite exhaustive tests were made, going so far, both machines operating under commercial load, to figure out the thermal efficiency and the British thermal units per electrical horse-power, as that was what was really desired after all. He was much surprised to discover that the Green-Wheelock engine showed a higher efficiency or used less British thermal units per electrical horse-power on the board than did the turbine. These tests were made under one-third load, half-load, full load, and fifty per cent overload, and after comparing the tests, and taking the whole proposition into consideration, he considered that the turbine showed itself to be a superior generating unit. As all guarantees on turbines are based on steam consumption, for the turbine alone, and as there are also certain guarantees as to certain degrees of superheat, the question arose as to whether applying the superheat to an engine as to the turbine would not be of equal value. It was found even more so, if anything, although on the other hand, a great deal of trouble was found in lubricating the cylinders of the engine. It has been running for some months with an average of seventy-five to one hundred degrees on the engine and there was still trouble in lubricating the high-pressure cylinders; but the economy on the engine, with superheat, is quite as marked as with the steam turbine. His conclusions were, in purchasing apparatus, not to be misled by guarantees as to the additional superheat. The speaker thought that the superheat costs practically as much as can be got in economy in steam coming from the turbine. The tests were made in their own shops, under their own supervision, and they were pretty sure of them.

Mr. W. H. Abbott remarked, in reply to Mr. Mailloux in regard to water in superheated steam, that they are operating two 1,500-kilowatt turbines with from 50 to 100 degrees of superheat, and in a number of cases they had water present in the steam; whether it is present always in a small degree, he did not know, yet there are times when the water comes there in greater or smaller quantities, and yet the thermometer will be registering superheat all the time. Of course, the thermometer is more or less lagging in its readings, but results of their experiments and experiences would indicate that they frequently could and do have water in fairly large quantities present in the steam pipe with a high degree of superheat.

Mr. Hopkins added that the plant he had referred to was originally designed not to have separators on the steam line of the engines, but having experienced the trouble which had been mentioned, they were compelled to add separators on all the engines, although they had 100 degrees of superheat. They find that they get water in the engines almost as badly as with saturated steam.

Mr. Mailloux remarked that this explained the difficulty—it was simply water entrained mechanically, and that the cause of it was a defect in the design of the piping or boilers, or in the operation of both, and that it could be remedied by a receiver placed near the turbine, or by the use of separator, as the gentleman had stated. With reference to the matter of economy, he thought that the steam turbine is more efficient in the lower stages of pressure than in the higher stages. This was so well known that a prominent English engineer has proposed to use the reciprocating engine and steam turbine in series, so to speak, using the reciprocating engine for the higher pressure stages, say, from 200 pounds and expanding the steam down to ten or fifteen pounds above the atmospheric pressure, and then using the lower pressure turbine with condensation. Under these circumstances it would be found that a few pounds of pressure, plus the condensation, would enable the turbine to develop as much power as the steam engine with the higher form of pressure. That is why things which are intelligible from a thermodynamic consideration are not a mystery. As the gentleman from Columbus had pointed out, there are other things which enter into the case. They were not concerned alone in the cost of fuel in the operation of a plant, as the cost of fuel is a small proportion, after all, of the total cost per kilowatt-hour. What they wanted was the total cost reduced and in that equation there entered many things, like space, maintenance, repairs, etc., and the bulk of evidence up to the present time indicated that the turbine will make up in other things for a slight discrepancy against it in steam consumption. There was a steam engine in Berlin built by one of the most distinguished firms in Switzerland, a triple-expansion, four-cylinder compound engine, a 5,000-horse-power unit, which running at very nearly full load has developed a horse-power-hour for something less than nine pounds of water per indicated horse-power-hour with superheat up to 600 degrees Fahrenheit or more. That was perhaps the world's record up to the present time, but that engine had sixteen valves, complicated mechanism, and a great deal of lubrication was required. It has been stated that doubtless the cost of maintenance and the cost of the extra lubrication of the cylinder, lubrication of the valve motion, etc., and all the expenses connected with the operation of that unit make it less economical when you come to consider the total cost per annum of producing the kilowatt-year. So it was an important thing to bear in mind that one of the reasons why the steam turbine appeals to us is that it simplifies the operation of the maintenance of the plant in other respects than that of economy of coal. The steam turbine had only begun its development, and the more it was developed the more it would approximate the results obtained by the steam engine.

Robert McCulloch, of St. Louis, enquired where Mr. Mailloux procured his coal, as he thought it was a significant matter in the production of power, and with most roads is greater than all the other items put together.

Mr. Mailloux referred the members to the transactions of last year, where that question was discussed and covered. In his capacity of consulting engineer he had to deal with problems where fuel varied from $1.50 per ton to $15 per ton, and he had stated quite distinctly in the discussions referred to that there is a certain critical price for coal at which the steam turbine is not preferable to the reciprocating engine, and that there was a price slightly higher at which the steam engine fell down in comparison with the

gas engine, and at a little higher price it laid between the gas engine and the Diesel engine, so that it was a pertinent question. It was the first duty of a consulting engineer when called upon to advise his client to investigate the cost of fuel.

Mr. Thomas Hawken, of Dover, N. H., said that he had charge of a station of the United Gas and Electric Company, in which are installed two 500-kilowatt machines, and since they had started up about three months ago they had been working very satisfactorily. They have had no trouble whatever with the lubrication of the turbines, and they had a twenty-one-hour test made and got the results on light loads, quarter, half and full loads and fifty per cent overload, and he considered the results as good as any secured with a first-class reciprocating engine. The output for the day was 4,400 kilowatts, and they run on the machine motor circuits, railroad circuits and lighting circuits, and the regulation was good. The coal consumption was four pounds per kilowatt-hour. As to the lubrication, he wished to state, for the benefit of those present, that he was told that it was necessary to have the oil cooled, but he found that after a couple of months the water would get into the oil and the oil became saponified and looked very much like lard; but he found it could be separated by putting a steam pipe into the oil. The people who sold the oil then advised that it was not necessary to cool the oil. It was claimed that the oil would give perfect results up to 400 degrees. He was doubtful, but tested the matter and found they had no bad results whatever, and the temperature is 140 to 160 degrees. They have a perfect return-water system for their plant—they pay a price of twenty-five cents per thousand gallons of water, but with this return system they find that it does not require over five and three-quarter pounds per kilowatt, so that their water bill is not very high.

W. H. Abbott said that the experience related by Mr. Hawken as to the deposits in the oil was interesting to him. In one of the plants for which his firm were consulting engineers they had a similar experience. The deposit Mr. Hawken referred to was said to be like lard; the deposit which they had was something like vaseline, a dark yellowish deposit. He did not think it was due to water in the oil, because as far as they knew there was no leak in the pipe, no collection of water which would indicate a leak, and yet in using different kinds of engine oil the best that the builders could recommend, they always had this deposit in rather large quantities, which was rather a serious matter, since they occasionally had to stop a turbine and clean out all the oil chambers.

Mr. Hopkins remarked that the turbines at Columbus are different from those at St. Joseph, Mo., with which he was familiar. There the pipe for the oil and the pipe for the steam leaving the step bearing are so arranged as to practically produce a balance between the oil and steam, and at that point they are having no trouble with water in the oil. He was not familiar with the detail of the method of piping, as it is a recent installation, but, as he understood it, it is the method of piping which the General Electric Company expects to adopt. The installation at St. Joseph is a 1,500-kilowatt turbine, and they have no trouble with sediment in the oil, or with water in the oil. With the 500-kilowatt turbine at Columbus they had the trouble the gentleman mentioned and they found that they had to change the oil.

"STEAM TURBINE POWER PLANTS."

J. H. BIBBINS.

The service requirements of a prime mover in electric railway work are more severe than in any other application outside of the rolling mill. The characteristics of the steam turbine seem almost ideal for fulfilling these conditions, since it operates at a high speed, thus offering an important regulating force; its overload capacity is large, and it is economical under fluctuating loads.

A series of tests run recently on a 750-kilowatt Westinghouse-Parsons turbine built for the Boston navy yard illustrates the range of economy. It was found that an economy of 13.77 pounds of steam per brake-horse-power-hour was obtained with a twenty-eight-inch vacuum, but no superheat; that 23.45 pounds was obtained with no vacuum and 100 degrees superheat, and that 28.26 pounds was obtained without either vacuum or superheat. With twenty-eight inches vacuum and 100 degrees superheat, the steam consumption was 12.99 pounds per brake-horse-power-hour at a slight overload.

As an index of the general trend of engineering practice, a large amount of data on the steam pressure, the superheat and the vacuum used in service has been collected. Forty-six turbine plants, varying in output from 400 to 40,000 kilowatts, have been studied. The following results were found: the pressure varies from 120 to 200 pounds, the superheat from zero to 180 degrees and the vacuum from twenty-four to twenty-eight inches. The average varies somewhat, depending on whether the number of plants or the aggregate capacity be taken as a basis. Considering first the number of plants, the pressure most generally used varies from 150 to 175 pounds, the superheat from zero to 100 pounds, and the vacuum from twenty-seven to twenty-eight inches. Taking as a basis the rating of the plants, the pressure most generally used varies from 150 to 175 pounds, the superheat from 100 to 150 degrees, with the range of vacuum last noted.

The nature of the saving due to vacuum and to superheat has been demonstrated by tests. These show clearly the relative advantages of the last few inches of vacuum. For example, plotting the rate of increase for each inch of vacuum, it is found that with twenty-five inches of vacuum the gain is but one per cent; with twenty-six and one-half inches the gain is three and one-half per cent, and with twenty-eight inches it is five and one-half per cent; the latter being an estimate.

The effect of superheat on economy is as striking as that of vacuum. Thus, starting with 150 pounds steam pressure, dry, saturated steam, with twenty-five inches of vacuum, the steam consumption is reduced from 16.45 to 12.66 pounds per electrical horse-power by raising the vacuum three inches and superheating to 140 degrees. These results were obtained on a 1,500-kilowatt turbine at full load. In round numbers, 100 degrees of superheat will ensure an increase in economy of one per cent, and an increase of one inch in vacuum (between twenty-five and twenty-eight inches), from three and one-half to four per cent, depending somewhat on the load. Using these figures as a basis of computing the net saving resulting from the use of high vacuum in a 2,000-kilowatt plant containing two 1,000-kilowatt units, it is found that by raising the vacuum two inches—from twenty-six to twenty-eight inches—the saving in coal per day will be from 3.5 to 1.3 tons, according to the character of the load.

Considering the floor space required for different sizes of the Westinghouse-Parsons turbine, the data from the forty-six plants show that with a normal output of 1,600 kilowatts, consisting of four 400-kilowatt units, the area of the engine room per kilowatt is 0.57 square foot. With a station rated at 4,000 kilowatts, consisting of four 1,000-kilowatt units, the area per kilowatt is 0.531 square foot. If the plant be rated at 22,000 kilowatts, and consists of four 5,500-kilowatt units, the area of the engine room per kilowatt is

0.277 square foot. This may be compared with the New York Edison company's station, the most compact of the great power-houses in New York city. In this design the area of the operating floor is 0.573 square foot per kilowatt.

Mr. Bibbins then quoted some figures which showed the generating cost secured by using steam turbines in five English power stations. The following averages were obtained: average rating, 2,946 kilowatts; load-factor, 14.42; cost of coal and the works cost per kilowatt-hour, 0.936 cent and 1.94 cents, respectively.

Mr. Bibbins outlined briefly the performance of the steam turbine in a number of plants. The records seem to show that the steam turbine is a machine of wide application, of rugged and permanent construction, responsive to excessive and sudden demands, is peculiarly suited for parallel operation under the most difficult circumstances, and is capable of yielding commercial results under extremely unsuitable conditions.

Mr. A. S. Kibbe, of Philadelphia, asked Mr. Bibbins whether the relative economy of the high vacuum would not apply as well to reciprocating apparatus as to the turbine.

Mr. Bibbins answered that it depended entirely on what advantage the engine is built to derive from the higher vacuum. He thought that he was not far from the truth in stating that an engine with a cylinder ratio of 1 to 4 did not usually expand below five pounds condenser pressure. It would, of course, become more and more economical as the vacuum were decreased, but the proportion of the rate of increase, as you might call it, is decidedly less than in the turbine, because the turbine does expand down to condenser pressure. That had been shown time and time again by taking the temperature of the exhaust end of the turbine. If a condenser can be built with twenty-eight-inch vacuum, the turbine can be designed so as to reach any condenser pressure. It was a fact that the turbine, without being made extra large or bulky, can take advantage of a high vacuum, where the engine can not directly.

W. H. Abbott stated that he had noticed Mr. Bibbins called attention to the large amount of air which is brought into the water by small leaks, and he wished to ask whether, reasoning from that standpoint, Mr. Bibbins would say he should not use open feed-water heaters, but rather use closed feed-water heaters, so as to exclude the air.

Mr. Bibbins answered that he did not know that he could answer the question from his personal experience, but the fact was apparent, however, that the more you can exclude air from the steam cycle the easier it will be to attain the higher vacuum. He thought that fact was brought out in almost every turbine plant. Of course, the air pump is built to remove the air, but every cubic inch of air that gets into the circulating system has to be taken out by the air pump, and that means power consumption.

Mr. Mailloux enquired whether Mr. Bibbins found any practical difference in the power required when the air pump handled air that was cool—when there is a cooler for the dry vacuum pump.

Mr. Bibbins answered that he could not reply to that question definitely, from the fact that he had never seen any tests made to determine that particular point.

Mr. R. H. Rice said that, in regard to the question of air, it seemed to him the open heater would contain less air than the closed heater, as the open heater would give an opportunity for the air to escape while the water was circulating, which the closed heater would not.

Mr. Hopkins remarked that he knew of two turbine installations, in one of which an open heater was used and in the other a closed heater was used, both using the same form of air pump and there was practically no difference which could be observed as to the quantity of air which was in the water.

"THE AMERICAN DIESEL ENGINE."

E. D. MEIER.

Mr. Meier described the principle of the Diesel engine, and referred to a number of plants now operating in this country in which this engine is the prime mover.

The question was raised as to the largest size in horse-power or kilowatt capacity of the Diesel engines that are now made, and the prospects of larger sizes being made.

Mr. Meier replied that at present they were building nothing larger than 450 to 500 horse-power. The largest being 500-horse-power engines. They are now putting up one of that size at Elkhart lake to drive a portion of Sheboygan & Elkhart Lake Railway. That will be running in about six weeks or two months.

Replying to the question as to the number of cylinders, Mr. Meier said that it contained six cylinders; it is composed of two engines coupled together with a dynamo between. The German firms had already built four engines of 400 horse-power each, four cylinders each, 100 horse-power to a cylinder, which they have been erecting for the street railway and light plant at Kiew, Russia. They expected to get to larger sizes in the course of the next year; would probably get to a 1,000-horse-power engine before long; no difficulty had been experienced so far. The difficulty in regard to large gas engines had been on account of the explosive action and the uncertainty of ignition, which has been largely overcome, and on account of the high temperature. The temperature in the Diesel engine is considerably less than in the gas engine and they had experienced no difficulty in the larger sizes. They naturally began with the small ones on account of experimental work.

The Railway Signal Association.

The annual meeting of the Railway Signal Association was held last week at St. Louis, the rooms of the St. Louis Railway Club in the second floor of the Transportation Building being used for the convention.

There was a good attendance of the signal engineers of the various steam railways and many matters of timely importance were discussed. Among those in attendance were the following:

J. C. Mock, Michigan Central; J. A. Peabody, Chicago & Northwestern; L. P. Clausen, Chicago, Milwaukee & St. Paul; H. C. Hope, C. St. P. M. & O.; R. W. Taylor, B. & O.; G. W. Dryden, B. & O.; H. D. Lowry, C. M. & St. P.; Azel Ames, Jr., Lake Shore & Michigan Southern; C. H. Morrison, Erie.

Tuesday evening Mr. Charles E. Brown, of the Central Electric Company, of Chicago, gave a very enjoyable dinner to the above members of the association and others at the Tyrolean Alps. Mr. George T. Manson and Mr. John Langam, of the Okonite Company, were present. The occasion was one of the pleasantest of the many social events occurring during the week.

Officers were elected as follows: president, J. C. Mock, Michigan Central Railroad, Detroit, Mich.; vice-president, Lawrence Griffith, Grand Central station, New York; secretary-treasurer, H. S. Balliet, South Bethlehem, Pa.

Meeting of the American Institute of Electrical Engineers.

The 190th meeting of the American Institute of Electrical Engineers will be held at 8.15 P. M., October 28, at the Chemists' Club, No. 108 West Fifty-fifth street, New York.

The following papers will be presented for discussion:

"The Telautograph," by James Dixon, associate; electrical engineer with the Gray National Telautograph Company, of New York.

"The Transposition of Electrical Conductors," by F. F. Fowle, associate; with the railroad department of the American Telephone and Telegraph Company, New York.

THE TELEGRAPHIC AMPLIFIER.

AN IMPORTANT AUXILIARY SIGNALING DEVICE.

An important telegraphic instrument has been invented and brought to a satisfactory practical state by Mr. Stephen Dudley Field. This instrument Mr. Field designates as the "Amplifier," and it is the result of several years of careful study and experimentation. The end sought by Mr. Field in his work was to develop an instrument which, when connected to an ocean telegraph cable, would enable the signals sent over the latter to be taken down by an ordinary Morse recorder. The instrument is, in a sense, a relay, but one of exceedingly great sensitiveness. The electrical impulses received over an ocean cable of considerable length are too weak to enable them to actuate any but the most delicate apparatus, if the latter depend upon the energy of these infinitesimal currents for its operating force. Mr. Field's amplifier avoids this difficulty by employing the electrical signals merely to direct the action of his instrument, in order that a local circuit may be closed through an ordinary Morse recorder.

Mr. Field has constructed several of these instruments, and has found that their operation far exceeds his expectations. Placing one of these amplifiers on an artificial cable with a variable period of two seconds, and using but one one-hundredth of a milliampere, he was enabled to send messages at the rate of thirty-two words per minute. These were taken down sharply by an ordinary recorder, as though the message were coming over a short land line. The speed was limited not by the sensitiveness of the amplifier, but by the skill of the sender.

This device proving to be so entirely satisfactory for cable working, and it being found that it was exceedingly delicate, it occurred to the inventor to try it for recording wireless messages. In wireless telegraphy there are a number of different responding devices, some of them of very great sensitiveness. The more sensitive the device—that is to say, the less the amount of energy required to operate it—the greater the distance over which it will respond to messages. Probably the most sensitive of these devices is the electrolytic responder invented by Dr. Lee De Forest. This instrument Mr. Field has found to be twenty times as sensitive as the telephone, but the device is of such a character that the energy set flowing in the local circuit is very small. It is usual to employ this responder in connection with a telephone receiver, the messages being read by ear. At the request of Mr. Field, the American De Forest Wireless Telegraph Company lent him one of the De Forest responders. Upon inserting his amplifier in place of the telephone receiver, and exposing the responder to Hertzian waves, the amplifier at once took up the signals, setting them down by means of the usual Morse recorder without any trouble whatever.

The device is of such a character that it can be at once applied to any telegraph system, and it is easily adjusted to obtain the best conditions. While it was primarily designed for use with telegraph cables, it would seem to have a much wider field of application. As noted, it can be used in wireless telegraphy not merely to detect messages so faint that the sensitive telephone receiver would not notice them, but it will actually put the message down on paper. It can be used in a composite wireless and wire telegraph system, receiving the wireless message and relaying this over a land line. It would thus appear possible to telegraph from Europe under the Atlantic and across the continent at one operation. Indeed, since the apparatus itself, being more sensitive even than the De Forest responder, is actuated by very faint electrical impulses, and calls upon some local source for recording or retransmitting the messages, it is hard to set a limit to the distance to which it will enable a telegraphic message to be sent directly.

Annual Report of the Western Union Telegraph Company.

The annual report of the Western Union Telegraph Company for the year ending June 30, 1904, by the president, Colonel Robert C. Clowry, to the stockholders, presented at the meeting, October 12, 1904, contains a number of interesting points. The capital stock outstanding is unchanged, namely, $97,370,000, of which $29,394,000 belongs to, and is in the treasury of, the company. The operating and general expenses, including taxes, were $15,736,592.24; the rentals of leased lines were $1,600,885.06; the maintenance and reconstruction of lines amounted to $3,627,196.06; the equipment of offices and wires amounted to $397,242.10, making a total expenditure of $21,361,915.46.

The total number of offices is now 23,458. The total number of messages was 67,903,973. This does not include messages sent over leased wires or under railroad contracts.

There was an increase of $81,703.64 in the revenues of the year and of $408,700.39 in the expenses. Of the last named amount $195,373.85 was in maintenance and reconstruction of lines, including nearly $100,000 for repairs to the company's transatlantic cables, and $183,354.93 was in operating and general expenses, including removal and improvement of offices, etc.

From the $6,729,744.98 profits of the year, $4,868,071.25 was paid for dividends and $1,157,700 for interest on bonds; the remainder, $1,861,703.73, was added to the surplus.

The net growth of the plant was, in poles and cables, 2,833 miles; in wires, 66,193 miles; in offices, 338.

Of the total of 1,155,405 miles of wire in the company's system at the close of the year, 290,507 miles were of copper; an increase in copper during the year of 44,257 miles.

The cost of new construction was $2,465,779.69.

The system of inspection referred to in the last annual report was continued throughout the year. Among other measures for improving the service was the establishment of a general division for the southern states with headquarters at Atlanta, Ga. Three districts in other divisions, which had grown too large for careful supervision, were divided and two new districts created out of them; one with headquarters at Dallas, Tex., and the other at Hartford, Ct.

At Boston, Mass., Wheeling, W. Va., and several other places arrangements were made with the company's landlords to thoroughly reconstruct and remodel the main offices. The leases of the main offices at Philadelphia and Cincinnati expired during the year, and as arrangements could not be made for their renewal, the company moved into new and modern buildings secured by long leases at both places.

The substitution of dynamo current for chemical cell main batteries has been continued so far as practicable, and, where power could not be obtained to operate dynamos, storage batteries have been employed. Such changes were effected at fifteen important battery centres during the year. The new method of generating current is not only more efficient than the old, but so much cheaper as to save during the first year the entire cost of making the changes.

Other departments have been the subject of careful study and improved methods have been steadily introduced. The system of transferring money by telegraph was reorganized, the rules governing it liberalized, and the scope of the system greatly extended, with the result that the latest returns from it show encouraging increases in receipts.

Contracts covering 2,512 miles of rail-

road were closed during the year with the following named railroad companies: Pittsburg Junction Railroad Company and the Ohio River Railroad Company; West Virginia Central & Pittsburg Railroad Company; San Pedro, Los Angeles & Salt Lake Railroad Company; Pittsburg, Carnegie & Western Railroad Company; St. Louis, Brownsville & Mexico Railway Company; St. Louis, El Reno & Western Railway Company; Trinity & Brazos Valley Railway Company; Memphis & Gulf Railway Company.

ELECTRICAL MINING NOTES.

BY SYDNEY F. WALKER.

THE USE OF COKE OVEN AND BLAST FURNACE GASES FOR COLLIERIES AND IRONWORKERS' ELECTRIC POWER STATIONS.

With the development of the use of electricity in mines, the question of power is constantly coming up. Many collieries make a large portion of their coal, all the small, into coke, and in the counties of Durham and Northumberland a large portion of the coal is ground up for the purpose of making into coke, as it has a higher value in the form of coke than as coal. In the process of burning the coke, the gases that form a part of the coal are driven off, leaving almost pure carbon; the more nearly the coke approaches to pure carbon, the better it is for the principal purpose for which it is employed—smelting the iron ore in the blast furnace. The process of smelting the ore in the furnace consists again of causing a combination of the oxygen with which the iron is combined in the ore with the carbon of the coke. In both cases, the burning the coal to coke, in the coke ovens and the smelting the iron ore in the blast furnace, a large quantity of gas is produced, consisting principally of carbonic oxide. It will be remembered that the process of combination of carbon with oxygen may be performed in two stages. When one atom of oxygen combines with one atom of carbon, carbonic oxide is formed, and when two atoms of oxygen combine with one atom of carbon, carbonic acid is formed. Carbonic acid is practically inert, so far as combustion is concerned. It prevents combustion, but carbonic oxide, if ignited, will in combustion give out heat just as coal does, or ordinary coal gas. Hence the gases that are delivered from the coke ovens and from the blast furnaces are available sources of energy and have long been used for firing the boilers for collieries and those for generating the steam for the blowing engines for the blast furnaces. Lately, however, blast furnace gas has been gradually coming into use for internal combustion engines and also coke oven gas. I mentioned last year the case of the Whitwood collieries of Messrs. Henry Briggs, Sons & Company, where coke oven gas is used of a calorific value of 550 British thermal units per cubic foot, as against ordinary domestic coal gas of 600 to 650 units. At the South Staffordshire steel works the blast furnace gases are used for power, the gas being used to drive the blowing engines which are of the internal combustion type and also to drive three compound continuous-current machines of 150 kilowatts each, the current from which is employed for motors in different parts of the works. There are three Premier gas engines of 320 horse-power each, a 550-horse-power engine, a Premier engine of 1,000 horse-power and a Crossley engine of 800 horse-power.

THE TROUBLES WITH BLAST FURNACE AND COKE OVEN GAS.

Blast furnace and coke oven gas are usually of very much lower calorific value than the ordinary coal gas, the proportion being that 100 feet of blast furnace or coke oven gas are required per indicated-horse-power, where from seventeen cubic feet to twenty feet of ordinary coal gas are required. The case of the Whitwood coke oven gases mentioned above, where the quantity of gas per indicated-horse-power is only seventeen cubic feet, is quite exceptional. At the South Staffordshire steel works the quantity of gas per indicated-horse-power is eighty cubic feet, the composition of the gas being thirty-three per cent of CO, five per cent of H and about five per cent of CO_2. The great trouble in using blast furnace gas and coke oven gas, but more particularly the former, is the dust that is brought over with the gas. This has been got over by an ingenious arrangement due to the Rev. Mr. Capelle, the inventor of the fan that bears his name, and that is very largely used in mines in all parts of the world. The arrangement consists of a succession of fans, usually electrically driven, into which a spray of water is injected, the water catches some of the dust and carries it on into a sealed tank where it is allowed to settle. Some dust is collected at each fan till practically all has been taken out. Another trouble is the gas that comes over from the furnace varies in quality and composition, so that with a certain admission to the cylinder, the engine using the gas would be given a certain horse-power for some time and then suddenly would begin to give less or more, according to the variation in the composition. The calorific value of the gas depends practically upon the percentage of carbonic oxide and of hydrogen, and inversely upon the percentage of carbonic acid. Hydrogen gas has a very high calorific value, and therefore the presence of a comparatively small percentage, over and above that required to neutralize the oxygen present, will considerably increase the calorific value. The presence of one of the carbureted hydrogen gases will also raise the calorific value, but they are rarely present in blast furnace or coke oven gases, except in small quantities. The trouble of the variation of the gases is overcome by keeping a reservoir of comparatively rich gas from which any shortage can be made up. There have been other troubles with valves and other parts of the apparatus, but they appear to have been overcome.

COKE OVEN GAS VS. ELECTRICITY FOR COLLIERS' HOUSES.

A somewhat odd competition came under my notice recently. At a colliery in Yorkshire they make coke on one of the latest improved methods, the by-products being recovered and the gas which is one of the by-products also. The gas is washed, scrubbed, in the usual way, enriched with petroleum, also in the now usual way employed in gas works, and delivered to the houses in the colliery village. The local company which works the gas, taking it from the colliery, has fitted all the colliers' houses with gas pipes and gas fittings, including arrangements for gas-cooking stoves, and it is not intended to allow any electric lighting company to enter the ground. This will be one of the cases so common in England where vested interests, though so recently created, will block any real advance in the development of electricity. Probably it would have been just as economical to have used gas for driving internal combustion engines, which would have run electric generators and furnished electric light. If the electric light becomes common in colliery villages in Yorkshire, the local company which is exploiting the gas in this village will have made a great mistake, as the Yorkshire collier may be trusted to see that he gets what his neighbor in the next village has, or he will go there to live. The distances between neighboring villages in Yorkshire colliery districts are often not great.

RUNNING GENERATORS IN PARALLEL AT COLLIERIES AND IRON WORKS.

I have consistently opposed the running of generators in parallel in a plant

that is employed for lighting or power, in industrial works. Running in parallel is, in my opinion, right in a central generating station, such as that supplying a town, where the engineer in charge has complete command of the whole apparatus, and can arrange that any generator shall generate any pressure that he pleases within certain limits, and can also arrange that any individual generator shall take any part of the load that he pleases. But the case is quite different where the plant is used in a works. Usually there is not the convenience that the engineer in charge at a central town generating station has. There is often no arrangement for altering the excitation of the field magnets, and in some cases no convenient provision for altering the supply of energy to the driving engines, and the result is that it is almost a matter of accident whether one machine takes all the load, the others motoring, or not. I recently had an opportunity of seeing this very well exemplified. At a colliery in Staffordshire, where they have evidently a man who understands his work, they gradually built up a plant, as is very common. First they had a 220-volt continuous-current machine. Then they fixed a second machine of the same size and the same pressure, connecting it in series with the first. This arrangement worked well. Then they put down a larger machine running at 440 volts pressure and then the troubles began. The electrician, who was apparently fully qualified, as he had also arranged an accumulator and a booster for charging it, tried very hard to work the 440-volt machine in parallel with the two 220-volt machines in series, but without success. He, himself, when running the plant, could get the two sets to run together for about an hour, but then the big machine always came in and took the load. The reason is very apparent. The wires on the armature of the smaller machines would heat more rapidly than those of the larger machine, hence their resistance would go up and the pressure at their terminals go down, and the machine whose pressure was higher would take the load. It used to be taught that by connecting the terminals of the machines together the pressure must be the same, but unfortunately that was technical college teaching. In practice, in my experience, you can not construct two machines so exactly alike that they will furnish exactly the same pressure at their terminals under all conditions. At the South Staffordshire steel works, the three 150-kilowatt generators run by the Premier gas engines, mentioned above, are connected in parallel; the only precaution being a reverse current release is fixed in the circuit of each machine. The attendant told me that at first they had the release magnets set for no load, but they found that it gave too much trouble to have them in this way, as they often broke circuit when the machines were being switched in. They are now set to come out with a small reverse current.

Transformer Action in Trolley Cars.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

Have just read with interest your comment in the ELECTRICAL REVIEW of October 15, on Mr. McGeorge's letter published in the *Times* of October 10.

You doubtless noticed in reading the letter, several fundamental errors which show, at least, that Mr. McGeorge is in no position to instruct the public on transformer action.

Some time after reading the letter, it occurred to me that, reasoning from his apparently superficial knowledge of the transformer, Mr. McGeorge might have struck upon the principle of self-induction and developed it to his own satisfaction regardless of the light of experience upon the subject, and ignorant of the present knowledge concerning it. It is not so much the induced charge in the surrounding metallic parts which Mr. McGeorge appears to fear, as the danger to the circuit itself from an excessive, self-evolved charge, due (according to his theory) to an unrestrained transformer or inductive action throughout the circuit, and the absence of a secondary circuit to act as a safety valve.

The statements on which this possible explanation of Mr. McGeorge's trouble is based, are quoted below:

"What is to prevent disintegration of the insulation or to secure immunity from fire or molten metal in case of congested currents of overwhelming amperage?"

"What is to prevent congestion if there be no secondary conductor to assimilate and reciprocate the magnetic emanations of opposite polarity to that of the primary?"

These might be taken to describe an imagined "extra current" or self-inductive effect. If such be the case, Mr. McGeorge evidently falls down in his assumption, quite plainly stated in another part, that the entire electric circuit emanates a concentrated magnetic field continually, as does the primary of the transformer which he describes. In other words, has not the correspondent pictured to himself the ordinary electric circuit as being in itself highly inductive, as though composed of a single inductive winding throughout its extent?

I do not mean to say, of course, that self-induction would produce any of the effects so vividly described, but merely to point to a possible origin of the correspondent's ideas.

In a later statement, Mr. McGeorge implies that a safeguard against the danger which he foresees would be the paralleling of all electric circuits by a secondary grounded circuit. Naturally his conclusions are no more correct than his hypothesis.

On the whole, it is rather unfortunate a letter such as Mr. McGeorge's should be presented to the public under so alarming a title. The more so because so free is the use made of the "complex vernacular" which the public is so apt to associate, even though erroneously, with matters truly scientific. On this account, the conclusions arrived at are likely to claim greater attention on the part of the public, even though the reasoning is unfathomable.

ROGER S. HUNTINGTON.

October 17, Brooklyn, N. Y.

The Michigan Electric Association.

The first annual convention of the Michigan Electric Association was held at Detroit, Mich., October 11 and 12. This new organization of electricians was formed during a morning session on October 11, at the Griswold House. About twenty-two gentlemen from all parts of the state gathered for this first meeting. Mr. E. F. Phillips, of Detroit, general manager of the Peninsula Electric Lighting Company, and also an officer of the Edison Illuminating Company, of Detroit, was the prime mover and acted as temporary president. Mr. F. S. Hubbell, of Milford, was the temporary secretary.

The purpose of the organization is to promote the welfare of electricians who are engaged in the electric lighting business, municipal lighting plants and in the general power business.

The programme arranged for the first meeting included a paper by Professor J. A. Allen, of the University of Michigan, on "Steam Economies in Small Central Stations," and one on "The Nernst Lamp as a Factor in Commercial Lighting," by E. R. Roberts. There was another paper by Professor G. S. Williams, of Michigan University, on "Water Power."

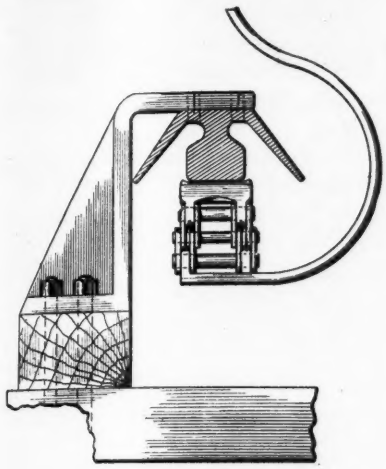
These papers were discussed by Alexander Dow, of the Detroit Edison Company; F. W. Wilcox, of Harrison, N. Y., and others.

At the session on Wednesday, October 12, officers were elected as follows: president, E. F. Phillips, Detroit; vice-president, W. A. Foote, Jackson; secretary and treasurer, J. E. Davidson, Port Huron.

The delegates were entertained by the Detroit Edison Company, and on the evening of Wednesday enjoyed a theatre party at the Lyceum Theatre.

Electrical Patents.

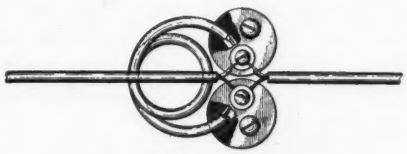
A third rail for electric railways (770,737, September 27) is the subject matter of a patent recently granted to Mr. Albert F. Chase, of Haddonfield, N. J., and one-half of the patent obtained thereon has been assigned to Stanley W. Rusk, of



THIRD RAIL FOR ELECTRIC RAILWAYS.

Philadelphia, Pa. In the embodiment of the invention, the depending portion of the rail has its widest part at the under-face thereof, and this width is proportionate to the face of a contact-shoe, intended to receive the propelling current from the rail. The upper part of the depending portion, which is the rail proper, preferably narrows toward the top into a neck-like form, terminating in a flat top from which spread outward on each side two oppositely disposed flanges, from which extend wings, which are preferably straight and must incline downward and outward and are of such lengths as to bring their lower ends in or about the same horizontal plane as the base or contact-face of the rail proper. In each of the flanges are bolt holes, drilled vertically through the same, to enable the third-rail conductor to be mounted to the rail-hanger. This construction of third rail provides a perfect water-shed over the rail proper and may be made integral therewith, the downwardly inclined extending wings also protecting the conductor laterally.

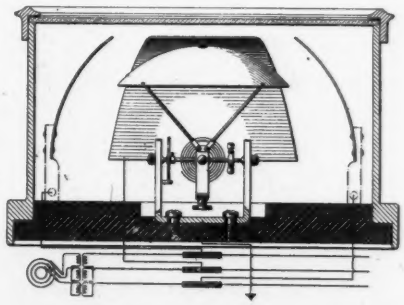
An improved thermostat (771,144, September 27) has been patented by Mr. John D. Gould, of New York, N. Y. The core of the thermostatic cable used in this invention is an electric conductor, such as copper wire combined with a wire or envelop of fusible metal, and an outer electric conductor of copper or brass wire insulated from the inner or core conductor, this outer member being preferably of fine wire, twisted about the insulating cover of the inner member for the purpose of giving the cable flexibility. When such a cable is run about a building and has its two members connected in circuit with an electric battery and an alarm-bell, it will serve as a thermostat, for as soon as the temperature at any part of the cable becomes sufficiently high to melt the fusible metal, it will expand and be forced through the insulating covering and make electrical connection between the inner and outer members of the cable, and thus close the circuit. It has been found advantageous to employ short sections of these cables as sensitive thermostats, in which the fusible metal will melt at a point not greater than 300 degrees and for many locations below that. Such thermostats may be connected with circuits of the usual copper insulated wire or with circuits of the thermostatic cable in which the fusible metal used has a melting point of 600 degrees or even higher. When short sections of such cables are used as thermostats, it is found that there is a tendency of the melted metal to move longitudinally of the inner conductor and to run out at the open end instead of



THERMOSTAT.

being forced through the insulating covering and making electrical connection with the outer conductor. To prevent this, the open ends of the sections are inserted into blocks of suitable insulating material and the ends of the fusible metal members there sealed with some material which is not readily affected by heat, and in order to facilitate the connection and the disconnection of the electrical conductors these insulating blocks are provided with one or more metallic terminals, to each of which one of the conductors of the short thermostatic sections of cable is connected. When connecting these short sections of cables with an alarm circuit, a single metallic terminal only will be needed in each insulating block. When, however, the two conductors of each short section of thermostatic cable are connected in series with the two circuit conductors, it will be found convenient and economical to have two metallic terminals in each insulating block.

A three-phase ground-detector (770,865, September 27) has recently been patented by Mr. Paul MacGahan, of Pittsburg, Pa., and assigned to the Westinghouse Electric and Manufacturing Company, a corporation of Pennsylvania. The operating mechanism of the instrument is enclosed in a case having a glass face and a back of suitable insulating material. Three stationary vanes, composed of suitable sheet metal and having approximately the form of truncated spherical triangles, are secured to suitable supports which are attached to the back at points approximately equidistant from each other, the convex sides of the vanes having outward exposures. Secured to the back by means of screws is a U-shaped yoke having adjustable screws near the free ends of its arms. The inner ends of the screws have concave bearing seats for the reception of the conical ends of a shaft to the middle of which a second shaft is rigidly secured, the two shafts being at right angles to each other. A collar is rigidly fastened to one end of the shaft by means of a set-screw, the inner end of a spiral spring being secured thereto and the outer end of this spring being secured to the split end of a pin, which is fastened to the adjacent arm of the yoke. Near the opposite end of the shaft an adjustable counterweight is provided for balancing the combined weight of the collar and the spring. The conical ends of the spring are seated in inner concave bearing seats of screws, which are mounted in the arms of a yoke. A collar, a spiral spring, having its inner end fastened to this collar, a pin to which the outer end of the spring is attached and a counterweight corresponding in structure and function to the like attachments for the shaft already described. An adjustable screw is provided in the



THREE-PHASE GROUND DETECTOR.

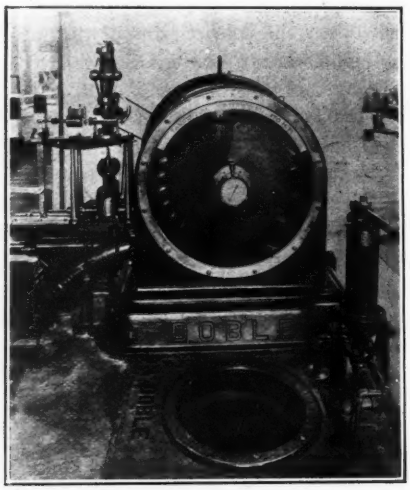
lower portion of the yoke for balancing the movable mechanism. Secured to the free ends of the last mentioned yoke are rods, on the outer ends of which a movable vane is mounted, the vanes being in the form of the segment of a spherical shell. In the centre of the vane is a spot, indicating which of the line conductors has become grounded. The stationary vanes are severally connected to metallic cylinders which surround the line conductors but are insulated therefrom, and connection to the ground is made in any suitable manner from the movable vane.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A High-Head Hydroelectric Installation at the World's Fair.

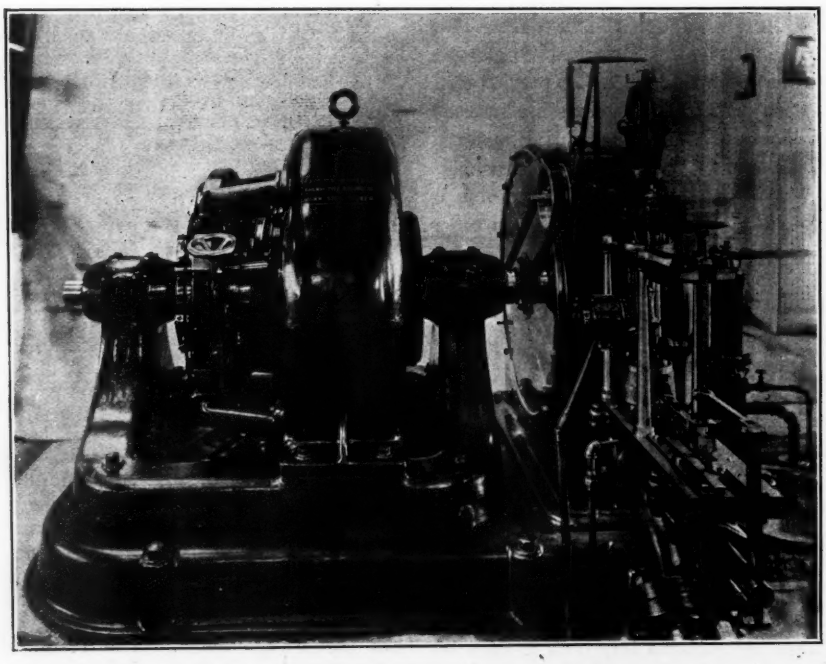
One of the most interesting exhibits in Machinery Hall, at the World's Fair, St. Louis, is the operating plant illustrating the method of generating electricity in high-head water-power plants. Several of these installations have already been erected on the Pacific coast of the United States, in the Rocky Mountains and in Mexico.



MODEL HIGH-HEAD HYDROELECTRIC INSTALLATION.

Since there is no high-head water at the World's Fair, the only way in which to show such a plant in operation was to combine it with a high-lift pump to furnish the necessary pressure of water. The method of undertaking this engineering feature was to bring together a joint exhibit representing the cooperative work of seven individual manufacturing and engineering concerns. The exhibit consists, therefore, of the following pieces of apparatus: a steam-driven mine pump furnishing water under 300 pounds pressure, and a tangential water-wheel, the latter being directly connected with a railway generator furnishing direct current at 550 volts to the intramural power plant. The speed and output of the water-wheel generator are regulated by a needle nozzle, the latter being directly operated by a hydraulic governor. In case of light load, the surplus water furnished by the pump is taken care of by a by-pass terminating in a relief valve. Provision has been made to demonstrate and keep on record during the entire time of operation the high efficiency of the tangential water-wheel by specially tested indicating and recording instruments.

A Venturi meter, with register and manometer, indicates the quantity of water delivered to the wheel, and a Metropolitan recording pressure gauge measures the pressure of the water, including the losses in the nozzles and its connections to the Venturi meter.



MODEL HIGH-HEAD HYDROELECTRIC INSTALLATION AT ST. LOUIS.

The speed of the water-wheel generator is shown by a shaft tachometer. The latter is driven without a belt, and therefore belt slip and incorrect indicating are avoided.

The companies which have contributed to this exhibit are as follows:

The Jeanesville Iron Works Company, Hazleton, Lucerne County, Pa., duplex, triple-expansion, condensing mine pump for a lift against 700 feet and a capacity of 1,200 gallons per minute.

The Abner Doble Company, San Francisco, Cal., tangential water-wheel with ellipsoidal buckets and needle-regulating nozzle, developing, under a head of 700 feet, 170 horse-power maximum at 700 revolutions per minute.

Crocker-Wheeler Company, Ampere, N. J., 110-D railway generator, 550 volts, 700 revolutions per minute, with a rated capacity of 100 kilowatts.

Lombard Governor Company, Boston, Mass., type J governor, operating the needle nozzle directly, and a balanced relief valve.

Builders' Iron Foundry, Providence, R. I., ten-inch Venturi meter, with register and manometer.

The Schaffer & Budenberg Manufacturing Company, New York city, shaft tachometer and Metropolitan recording pressure gauge.

Hubbell Pull Attachment Plugs.

The rapidly increasing use of electrical household utensils and the demand for a simple form of attachment plug have afforded an opportunity for the exercise of a great deal of ingenuity in the design of such a device. There are illustrated

FIG. 1.—THREE-WAY CONNECTION PLUG.

herewith several styles of pull attachment plugs made by Harvey Hubbell, 120 Liberty street, New York city. The cord

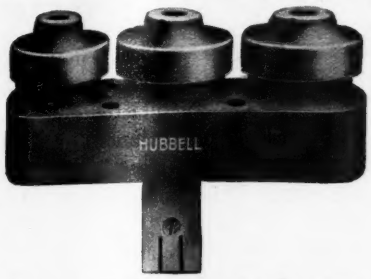


FIG. 2.—THREE-WAY PLUG FOR CHAPMAN RECEPTACLE.

is secured to the cap, which is detachable from the base by a straight pull. The base is a solid piece of porcelain, and is screwed into the socket or receptacle, after which the cap, with the cord attached, can be inserted. By this means there is no twisting of the cord.

An important feature of these plugs is that the caps are interchangeable, and one cap will fit any plug in the entire system.

FIG. 3.—KNIFE-BLADE CONTACT PLUG.

This admits of using any number of caps with the same base. Fig. 1 shows a multiple attachment plug. This plug is designed to screw into the ordinary socket, and the one receptacle may be used to tap current for three separate purposes. The plug shown in Fig. 1 is made up with two plugs and one lamp push. This plug is the same as that shown in

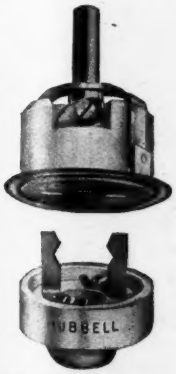


FIG. 4.—CHANDELIER PLUG, WITHOUT CASING.

Fig. 2, with the exception that the receptacle shown in Fig. 2 is equipped with three plugs, and is also equipped with a Chapman end. This device is the same in every respect as the receptacle described above, except that it is designed to fit a Chapman receptacle. This is a convenient device for carrying current to fans, desk lamps, heating apparatus, etc., making it possible to attach or detach any one of them without disturbing the others. Fig. 3 shows a knife-blade contact plug.

Fig. 4 shows a chandelier plug without casing. This chandelier plug is a modifi-

FIG. 5.—CHANDELIER PLUG, WITH CASING.

cation of the regular attachment plug, and is so designed that it can be used in a ball or sphere at the bottom of the chandelier or cluster. Fig. 5 shows a chandelier plug with brass casing. This plug is the same in every respect as the one shown in Fig. 4, except that it is enclosed in a brass casing so that it can be attached to the bottom of the chande-

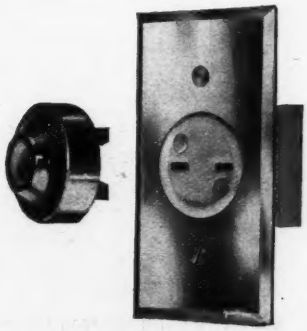


FIG. 6.—FLUSH PLUG AND RECEPTACLE.

lier. The casing may be made of any finish to match the fixture.

Fig. 6 shows a flush plug. This plug is designed to fit all standard junction boxes. The characteristic of detaching it with a straight pull, and the easy method of attachment, eliminating twisting of the cord, make it a popular article. The flush plug is furnished in polished brass, old brass, polished nickel, oxidized copper and other standard finishes.

Telephones on the Northern Pacific.

The Northern Pacific Railway, it is stated, is about to complete a telegraphone system between Pasco, Washington and Jamestown, N. D. This loop will connect the two ends of the company's present service and establish connections along the line from St. Paul to the Pacific Coast.

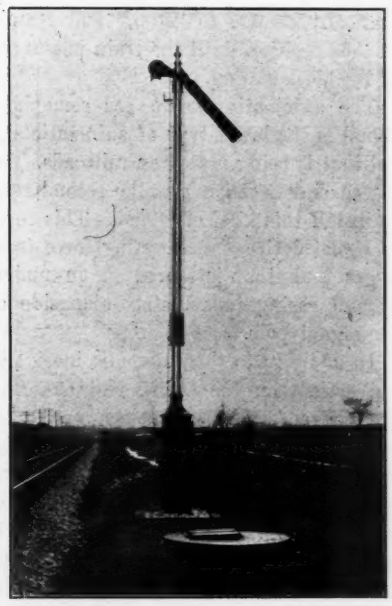
Automatic Block Signals on the Queen and Crescent Route.

The Queen and Crescent route (C., N. O. & T. P. Ry.) is unique among the railroads of the world, in that it is the only

AUTOMATIC SIGNAL AT "STOP."

single track road protected by automatic block signals practically from terminal to terminal; ninety per cent of the road being protected in this manner. Other block signals adapted to local conditions are used on the remaining ten per cent of the line.

These signals can be noted at intervals



AUTOMATIC SIGNAL AT "PROCEED."

of from one to three miles along the track. The controlling force consists of an electric current running through the

rails and acting on the magnets which hold the signals at "proceed."

A cutting off of this current either through a broken rail, a misplaced switch, a rail across the track or a train or car standing or moving, will cause the signal to assume, by mere force of gravity, the position "stop."

There are three distinct forms of electric block signals: the "semaphore," "disc" and "banner" signals. The semaphore signals on the left, as seen from the rear of the train, west side of the track, present to the engineman first, "proceed" position; that is, at an angle of forty-five degrees if the track is clear, the blade changing to "stop," or a horizontal position as the locomotive passes it. With the "banner" signal the edge of a red banner in an iron yoke is presented to the engineman if the track is clear, and the "banner" making a quarter revolution to "stop" position, filling the yoke as the locomotive passes it.

The "stop" position will be held until the train has passed into the next block, perhaps two miles in advance. The rear of the train is thus protected against any train that may be following.

At the same time the signals on the east side of the track being set in the "stop" position a long distance in advance of the moving train, affords perfect protection from trains moving in the opposite direction. Those signals, as the train proceeds, change from red to clear or "proceed." While the train is still two or three miles away these signals automatically change to "stop," and remain in that position until the train passes out of the block section.

The automatic electro gas semaphore signal is the latest type of automatic signal that is being placed on railroads. The Queen and Crescent was the second road to install this kind of signal. This form of signal derives its operating force from a gas tank that is stored in an underground casing immediately alongside of the signal pole.

In addition to the automatic block signal system on the Queen and Crescent, the electric train staff block system is used. This system is an American adaptation of the English method of handling trains, and consists of giving each train passing into the block, a staff, which is practically a "key to the situation." (Only one train at a time can secure the staff.) The staffs are small metal cylinders with slots in them, that are kept in a frame at the limit of the block and are automatically locked in this frame. These staffs are withdrawn by the operator at the end of the block when he has permission to do so from the opposing operator, and are then used to unlock the signal which governs the movement of a train into the block and are then placed in a rubber hoop which is delivered to the train coming into the block—half of the staff being presented to the engineman on the engine, and half to the conductor on the rear of the train. This is equivalent to giving the train orders that they have absolute "right in the block."

Passengers on the Queen and Crescent may perhaps note on leaving Cincinnati and at other points along the line, that the trainman on the rear end received a rubber hoop from the ground. This hoop is part of the staff system as explained.

Exhibit of the Bristol Company at St. Louis.

The advantage of the electric train system is that trains are handled through the territory governed by this system, altogether by the train staff system, and traffic in both directions can be moved more quickly over stretches of single track by this method than by the automatic block signal system.

The staff blocks are located at the terminals of divisions, or at other points along the line of the road, where traffic naturally becomes congested more than it does between terminal points. This system and the automatic block system have reached a highly developed state on the Queen and Crescent route and make for great safety in travel on the Queen and Crescent.

Exhibit of the Bristol Company at St. Louis.

The display of the recording instruments for pressure, temperature and electricity made by the Bristol Company, of Waterbury, Ct., is located in the Electricity Building, World's Fair, St. Louis. The accompanying illustration gives a good idea of the appearance of the booth, which is twenty-two feet long by twelve feet wide. This booth contains a large variety of recording instruments for pressure, temperature and electricity. The instruments record continuously with ink, upon graduated revolving charts, all changes that occur, so that a record of a period of twenty-four hours or more may be observed at a glance. Many of the instruments are in actual operation and may be inspected by visitors, to show the manner of construction and scientific principles upon which the operation depends. There is also opportunity for understanding the extreme sensitiveness and accuracy it is possible to obtain in commercial instruments of precision.

Recording water-level gauges are shown for ranges from full vacuum to 10,000 pounds per square inch; recording thermometers and pyrometers for ranges from sixty degrees below zero to 1,200 degrees Fahrenheit. The recording thermometers are made in many forms, for application to all industrial requirements. Recording voltmeters, ampere and wattmeters for both alternating and direct current are shown, including a large variety of ranges suited to commercial demands for different voltages and currents in electric light, power and railway plants.

Recording wheel-level gauges are shown in operation, and there is also included a new instrument designated as a thermometer-thermostat. This instrument is so constructed that it may be used to give an alarm or set in operation temperature-regulating apparatus at any predetermined point.

There is also shown a full line of Bristol's patented steel belt lacing, including styles and sizes for all varieties and thicknesses of belting.

The Case Controller.

The problem of developing a controller that would successfully handle the heavy service found in steel mills or, in fact, series-wound motors for every class of hoisting and crane service has been fraught with many difficulties.

Crane builders have realized this condition perhaps more fully than those who have not been obliged to confront the difficulties regularly in their daily work. It is not strange, therefore, that the problem should have been taken up and worked out by the engineering forces of the Case Manufacturing Company, of Columbus, Ohio, builder of cranes and other hoisting apparatus.

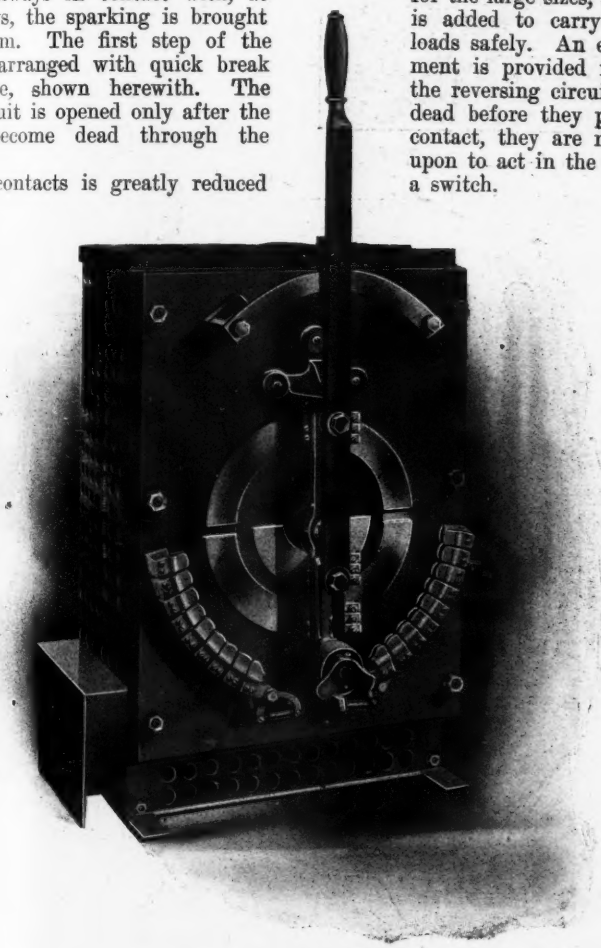
The Case controller has been built for hard service. The contacts are of hammered copper and phosphor-bronze with unusually large areas.

The contact is made by passing a hard copper disc between contact jaws, and as this disc is always in contact with, at least, two jaws, the sparking is brought to a minimum. The first step of the controller is arranged with quick break contact device, shown herewith. The reversing circuit is opened only after the lines have become dead through the device.

Arcing at contacts is greatly reduced by reason of the strong magnetic field always present at the knife blades, the air-gap between the blade being only one-half inch. The blow-out coil is well constructed, being form wound, dipped in insulating compound, baked, mumified and again dipped in an insulating paint. Mica and asbestos are liberally used throughout, and accident from grounds or short-circuits practically eliminated.

The reversing contacts are of brass, machined true, while the reversing contact fingers are of hammered copper, carefully machined. As will be noted, these fingers are carried on phosphor-bronze springs of large section and, for the large sizes, a "pig tail" is added to carry the heavy loads safely. An easy adjustment is provided for, and as the reversing circuit is always dead before they pass off the contact, they are never called upon to act in the capacity of a switch.

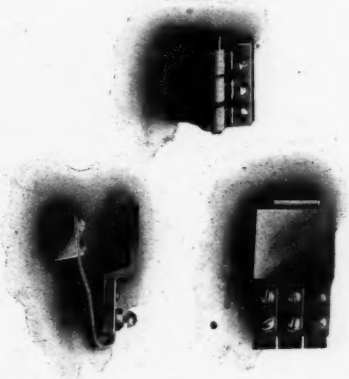
QUICK BREAK CONTACT.



CASE TYPE "F" CONTROLLER.

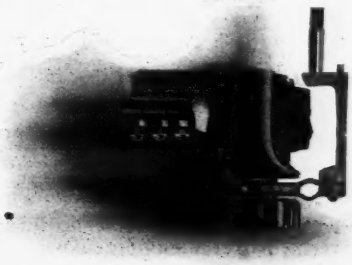
Iron wire resistance coils are used, the wire being wound on asbestos tubes. The construction allows of easy replacement of a tube should repairs be necessary. The wiring between coils and controller is done in the most approved manner; asbestos and mica insulation being freely used. The terminals are mounted on a slate board at base of controller.

The rolling disc contact is shown passing between the knife blades, the action being such as to keep the contacts in perfect condition, and the rolling contact adding to the ease of operation.



REVERSING SWITCH FINGERS.

For foundry hoisting, where cores and cope handling make necessary a very close regulation of the motor, an auxiliary lever is placed on the controller by means of which the number of speed variations is doubled. With this construction, a series motor may be controlled fron ten per cent of its rated speed to maximum speed under any load up to its rated capacity.



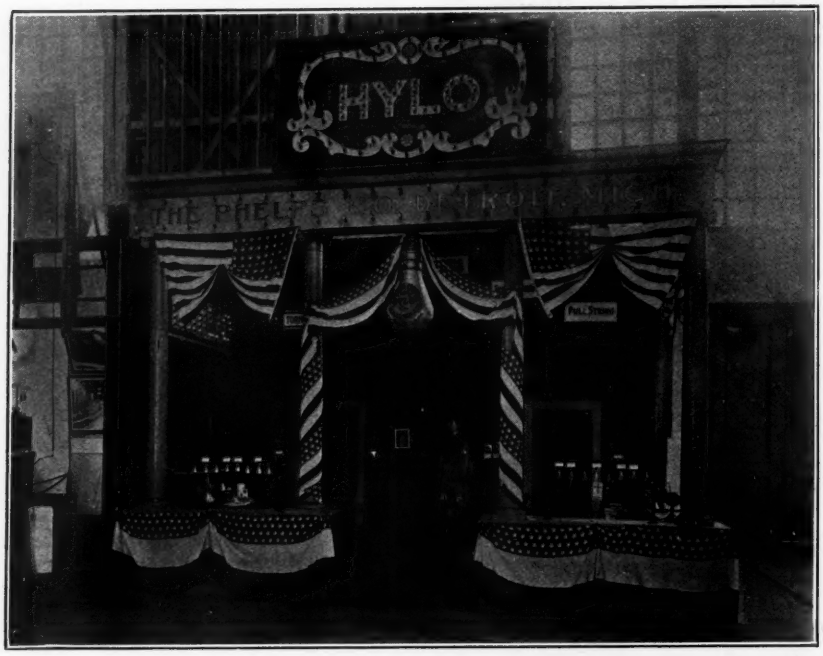
CONTROLLER LEVER ASSEMBLED.

KNIFE CONTACT ASSEMBLED.

The Case controller is made in sixteen different sizes, for motors from one to one hundred horse-power.

The Exhibit of the Phelps Company.

The Phelps Company, Detroit, Mich., is displaying its various forms of incandescent lamps in a remarkably attractive booth at the World's Fair. This exhibit includes the well-known "Hylo" turn-down lamp, the "Hylo" double-filament lamp, the "Hylo" flasher, and the more recently introduced "Skedoodle" plug. In the centre of the exhibition space is a lay figure of a woman in the act of operating the "Hylo" turn-down lamp. Demonstrations are given of the operation and current consumption of these various forms of lamps. This is one of the most popular booths at the fair.



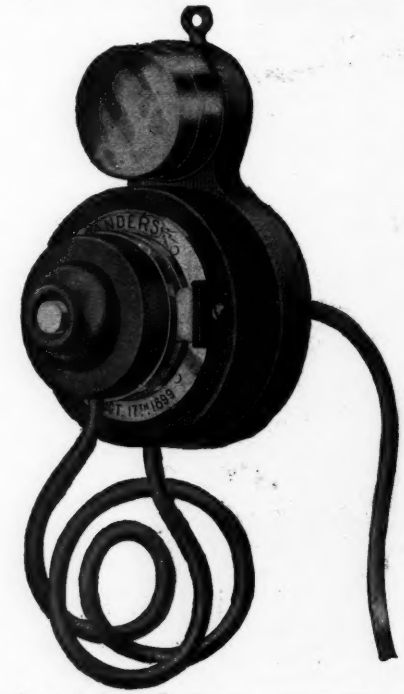
THE EXHIBIT OF THE PHELPS COMPANY, AT ST. LOUIS.

Liberal Awards to the Allis-Chalmers Company.

The Allis-Chalmers Company has announced that it has been awarded the highest prizes at the St. Louis Exposition. These include the grand prize in the department of steam engineering, electricity and mining machinery. The company was also awarded a gold medal for the Bullock system of operating variable speed electric motors for driving machinery. One grand prize was for the Allis-Chalmers "Big Reliable" engine. Another grand prize was for the Bullock electric generator. The large engine and the Bullock generator comprise the unit which supplies current for the decorative lighting and a large portion of the power at the exposition. Another grant was for the company's exhibit in the department of mining and metallurgy.

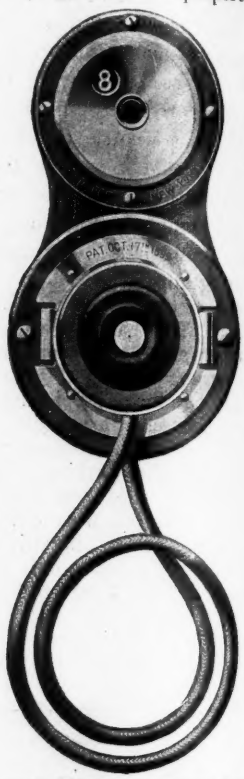
A Novel Push-Button Telephone.

The accompanying illustrations show a new form of eight-station, selective ringing, central battery telephone. This telephone is manufactured by the Edmonstone Company, 105 Chambers street, New York city, under the patents of the Anders push-button telephone. This apparatus consists of an electric telephone and push-button in one. The instrument may be used at will either as a speaking or as a signaling instrument, and is also a transmitter and receiver combined. The apparatus illustrated herewith is so arranged that it may be used as a portable party line instrument, and it is also equipped with a selective calling device calling eight stations.



PUSH-BUTTON TELEPHONE WITH BUZZER.

The Edmonstone Company has secured the entire rights to all properties and patents of the Anders push-button telephone. The Edmonstone Company is an entirely new organization, and is backed by substantial financial arrangements for the manufacture of this specialty.



PUSH-BUTTON TELEPHONE WITH SELECTIVE CALL.

The Annual Dinner of the Iron and Steel Institute.

The Iron and Steel Institute, of London, will hold its annual convention in New York city, October 24 to 27. The convention will follow the arrival of about 350 members and their friends from England.

The annual dinner will be given on Wednesday, October 26, at 7.30 o'clock, at the Waldorf-Astoria Hotel, Fifth avenue and Thirty-fourth street, New York city.

The One Hundred and Fiftieth Anniversary of the Founding of Kings College.

In commemoration of the 150th anniversary of the founding of Kings College, the trustees of Columbia University, New York city, will tender a reception at the university, 116th street and Morningside avenue, on Friday afternoon, October 28, from three to six o'clock.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRIC TRACTION SYSTEM IN CHINA—Bids for the construction and operation of an electric traction system in Shanghai, China, will be received up to March 31, 1905. Fearon, Daniel & Company, 96 Wall street, New York city, are interested in this project. The proposed road will be twenty-four miles long.

TO COMBINE WISCONSIN ELECTRIC LINES—The merger of the electric roads of the Fox River valley from Fond du Lac to Green Bay, Wis., is the purpose of a movement now under way. Milwaukee electric railroad interests it is understood will control the combination. There is now a complete line of electric railway from Fond lu Lac to Green Bay, connecting Fond du Lac, Oshkosh, Neenah, Menasha, Appleton, Kaukauna, Combined Locks, Depere and Green Bay. The various parts of this line are now in full operation. The distance covered is something over sixty miles.

NEW MARCONI STATION—A contract has been let for the erection of a station at Port Morien, about five miles from Glace Bay, Nova Scotia, by the Marconi company. The contract calls for the dismantling of the present towers at Table Head, and the erection of new ones of the same height, 215 feet, as well as the removal of the operating room and power-house to the new location. The Marconi company has purchased 400 acres of land, where the new station is to be erected. The station will be in the centre of the property. The towers will be built on similar plans to the present ones, but four miles inland. They will be the most powerful yet built by the Marconi company.

LIGHTING RATES REDUCED BY THE BROOKLYN EDISON COMPANY—A reduction of twenty per cent on the price of electric light service has been announced by the Edison Electric Illuminating Company of Brooklyn, N. Y., to take effect on January 1, 1905. This is in accord with the policy of the company to reduce the expense of its service to the public in proportion to the reduction of cost in the manufacture and transmission of power. The secretary of the company, Mr. W. W. Freeman, has announced that it is expected that the new rate will bring the company a much larger volume of profitable business. The use of electric lighting in Brooklyn residences alone has increased at the rate of twenty-five per cent. The price is still somewhat higher than that of gas, but there are advantages in favor of the electric light that stand unquestioned as to results.

TRANSFER OF OWNERSHIP OF LARGE PENNSYLVANIA PUBLIC UTILITIES—It has been announced that the control of the Philadelphia company, the public service corporation which operates street railways, an electric lighting system and a number of natural gas producers of Allegheny County, has passed to the United Gas Improvement Company interests of Philadelphia, Pa. The Philadelphia company was formed under the laws of Pennsylvania, May 24, 1884. It is understood to control nearly all of the public service utilities of Allegheny County. In January, 1899, control was acquired by a general consolidation of lighting and traction organizations in Allegheny County and the vicinity. The authorized capital of the company is $30,000,000 common, and $6,000,000 preferred stock. Of this there has been issued $28,953,029 common, and $5,744,812 preferred.

MEXICAN ELECTRICAL NOTES—It is said that negotiations have been practically completed for the acquisition of the existing horse-car line in Chihuahua, Mexico. The Mineral Railroad, operated by steam, has also been acquired. Both of these lines will be converted to electric traction. The contract for rails, equipment, etc., will entail an expenditure of about $1,000,000. A large water-power plant is to be built on the Amacusao river, state of Morelos, Mexico, for the purpose of supplying electric power for lighting and general use in and around Jojulta. Samson Lang, of Mexico, is interested in the project. The Occidental Construction Company, of Mazatlan, Mexico, proposes to construct an electric traction system in Mazatlan, a Pacific coast seaport town. This company is also primarily interested in a proposition to build a road between Mazatlan and Culiacan, the capital of the state of Sinaloa, Mexico. Lewis Warfield is general manager of the Occidental company.

A LARGE ELECTRICAL SECURITIES COMPANY INCORPORATED IN NEW YORK STATE—The Electrical Securities Corporation has been incorporated at Albany, N. Y., with a capital of $3,000,000. The principal office is in Schenectady, N. Y., and the purpose of the corporation is to manufacture and deal in electrical, gas, water and steam-power machinery. The stock is divided into $1,000,000 preferred and $2,000,000 common. The directors are: W. C. Lane, Pliny Fisk, Wilbur C. Fisk, F. L. Eldridge, Oscar L. Gubelman, G. M. Cumming, W. M. Barnum, C. A. Coffin, William C. Cox, Adolphus Smedberg, Jr., Paul S. O'Connor, Robert Maclay, William T. Kaufman and F. W. Walz, of New York; E. T. Stotesbury, of Philadelphia; Gordon Abbott and James J. Storrow, of Boston; M. B. Johnson, of Cleveland; M. J. Perry, of Providence, R. I.; Edward C. Palmer, of Morristown, N. J.; Harry S. Babcock, Jr., of Flushing, L. I.; S. M. Hamill, H. W. Darling and E. R. Coffin, of Schenectady.

ELECTRIC LIGHTING.

VALE, ORE.—A line has been installed between Vale and Dell, *via* Malheur City.

TUSCUMBIA, ALA.—The Sheffield company is now lighting the streets electrically.

COATESVILLE, PA.—An independent electric light company has been organized.

SUMNER, IOWA—The town has voted to grant a franchise for an electric light plant.

JENNINGS, LA.—It is stated that the Jennings Oil Company will install an electric light plant.

MORRISVILLE, N. Y.—A new 100-horse-power engine is to be installed in the electric light plant.

JAMESTOWN, TENN.—The electric light plant at Dyer, which was destroyed by fire, is being rebuilt.

PORTLAND, MASS.—The Consolidated Electric Light Company will install a conduit system for its wires.

STREATOR, ILL.—The People's Light and Railway Company, has placed its lighting plant in operation.

ITHACA, MICH.—The city council has awarded contracts for an electric lighting plant. The cost will be about $13,000.

BRIGHAM CITY, UTAH—The citizens of Willard are considering the question of installing an electric light plant.

INDEPENDENCE, KAN.—W. Nees has been granted a five-year franchise, and five months in which to put in a plant.

JEFFERSON CITY, MO.—The local electric light plant has been sold to W. N. Horner, representing a Chicago syndicate.

HAWARDEN, IOWA—A contract has been awarded to E. C. Bennet & Company for repairs to the electric light plant.

AGAWAM, MASS.—The Electric Light Company, of Suffield, has extended its system to Agawam and is lighting the village streets.

THERMOPOLIS, WYO.—The entire plant of the Thermopolis Electric Light Company has been destroyed by fire. It will be rebuilt at once.

NEWPORT, N. H.—The Newport Electric Light Company has purchased the plant at Sunapee and will soon have a line strung to that place.

OAKLAND, CAL.—An electric company has been formed at San Diego to supply Oceanside with light. A plant to cost $25,000 will be erected.

PROVIDENCE, R. I.—The Narragansett Electric Lighting Com-

pany is preparing its poles and wires for the installation of an all-night service.

TIMPSON, TEX.—The electric light plant has been sold to W. M. Waterman.

GOSHEN, IND.—The Hawks Electric Light Company is installing a new General Electric generator with a capacity of 7,000 lights.

CEDAR RAPIDS, IOWA—The Interurban and Electric Light Company has contracted for an 800-kilowatt generator and a 1,500-horse-power engine.

ALLIANCE, OHIO—A new 250-horse-power engine and a 150-kilowatt generator are being installed in the plant of the Alliance Gas and Electric Company.

HARTWELL, GA.—Work has begun on the erection of the new electric light plant for Hartwell. It is expected that the plant will be installed in about six weeks.

SHELBYVILLE, ILL.—The contract has been let for a $10,000 addition to the Shelbyville Water and Light Company's plant. The plant will be opened January 1.

LANCASTER, N. Y.—The village of Sloan has made an arrangement with the Depew & Lancaster Light and Power Company for the electric lighting of the village.

NEW WATERFORD, OHIO—The municipality will vote November 8 on the question of issuing bonds in the sum of $5,000 for the installation of an electric light plant.

LINDSBORG, KAN.—Lindsborg will install electric lights. A committee has charge of the work, and it is expected to have the plant established within a few months.

TEMPLE, TEX.—The city council has made a new contract for street lights with the Temple Electric Light Company, the contract being for three years at $100 per month.

PITTSBURG, PA.—The Braddock borough council has made a new contract with the Allegheny County Light Company for 120 arc lights for five years at $75 each per year.

MOULTRIE, GA.—The Moultrie city council has let the contract to H. T. Rogers, of this place, to erect a new power-house at the city light and water plant. Work will begin at once.

BISHOP, CAL.—All the material for the new plant of the Goldfield Electric Light and Power Company has been received. It is expected that lights will be turned on within sixty days.

CLYDE, KAN.—Maynard E. Maggart, of Chicago, will begin preparations for the building of an electric light plant here about November 15. The plant will cost between $8,000 and $10,000.

ASTORIA, ILL.—The Astoria electric light plant has been sold by S. and John D. Atkinson to William Falkenstein and others. The new owners contemplate making some substantial improvements.

ROSEBURG, ORE.—A petition to the Oregon legislature asking that the charter of the city of Roseburg be amended so as to enable the city to own and operate its own water and light plants is being circulated in Roseburg.

MILWAUKEE, WIS.—As the result of a report made by a special committee which visited other cities, the controller has signed the bond ordinance which is to give the city $150,000 to start a municipal lighting plant.

NEWPORT NEWS, VA.—The work of installing a new electrical system at Fort Monroe has begun. The fortress will be equipped with new telephone, light and signal systems, and the contracts will amount to about $75,000.

SHELBYVILLE, ILL.—The electric light plant at Moweaqua has been sold to Bryce Smith and W. F. Corrington. The consideration was $10,500. The new owners will spend about $3,000 on new machinery and other improvements.

SARATOGA SPRINGS, N. Y.—The Saratoga Gas, Electric Light and Power Company has been awarded a four-year contract for city lighting. Arc lamps of 2,000 candle-power each are to be furnished at the rate of $90 per year, as against $96 in former years.

SYRACUSE, N. Y.—The annual meeting of the Syracuse Lighting Company was held October 4 at the offices of the company in this city. The only important business transacted was the adoption of a resolution increasing the number of directors from thirteen to fifteen.

BROXTON, GA.—The city council by a unanimous vote has granted A. G. Garbutt an electric light franchise. In his application for the franchise he stated to the council that he would have the plant in operation by December 1, 1904. The city secures arc lights at $70 per arc per year.

CROWLEY, LA.—The city has purchased a new thirty-five-horse-power engine, costing $35,000, for the municipal electric plant. It is intended to place the street lights in operation again as soon as the new boiler is installed. The city has practically been without street lights for two years.

YORK, PA.—The Edison Electric Light Company will continue to light the city streets for the next five years. At a meeting of the light committee its bid of thirteen and one-half cents per light was accepted. The bid of thirteen and one-half cents is for each light for the period of one night. There are 360 arc lights in the city.

JERSEY CITY, N. J.—Contracts for the building of conduits underground on Washington street, Hoboken, have been placed by the Public Service Corporation. The conduits will be used for all electric light wires, electric feed wires and all other wires used on this thoroughfare by the Public Service Corporation, except the trolley wires.

SUPERIOR, WIS.—The company of Iron River and Nebagamon people that secured a right from the legislature to use the water power of the Brule river will shortly commence the work. The plans contemplate the building of a dam a mile and a half above the village of Brule. A large power-house will be erected and the electric power transmitted to different points.

DENVER, COL.—The German Gulch Gold Mining and Leasing Company has filed its articles of incorporation in the office of the secretary of state, with a capital of $200,000. The operations of the company will for the most part be confined to Silver Bow County, Mont., and it is proposed to furnish electricity to Butte and adjoining towns for lighting and power purposes.

BOSTON, MASS.—The Edison Electric Illuminating Company has offered the Newton city authorities $1,000 to be allowed to run a line of feed wire through certain streets and lands belonging to the city. This line of wire would supply the business and resident portions of Newton with both arc and incandescent lights and furnish illumination for Natick and Needham.

MUNCIE, IND.—The Muncie Electric Light Company is preparing for the erection of an addition to its plant, which, with the equipment, will cost in the neighborhood of $35,000. The adjoining lot on the north was purchased by the company some time ago, and the alleyway separating the plant and the lot will be used as a part of the site. The building will be 125 by 60 feet and constructed of brick and iron.

MOYIE, B. C.—An electric light and power plant will be installed at Moyie. R. E. Kinsey recently applied to the government, and has been granted 800 inches of water in Lamb creek. He has purchased five acres of ground as a site for the plant. The plant will be of 550 horse-power, and will be used for lighting the town, also to furnish power for near-by mines. The site of the proposed plant is about two miles from Moyie, on the Clark farm.

MAUSTON, WIS.—The Mauston Electric Light and Power Company and the Mauston Telephone Company have been sold to a company composed of business men of this city. The name has been changed to Mauston Electric Service Company, and the plants will be completely refitted. The company also acquired the water rights of the light company and proposes to rebuild the dam and make arrangements so that the surplus power can be utilized to advantage. The officers elected are: P. D. Curran, president; William Case, vice-president; A. W. Hasig, secretary; S. Basford, treasurer; G. J. Thew, electrician. In addition to the officers, S. F. Howard and the Rev. P. Becker were elected directors.

TELEPHONE AND TELEGRAPH.

NEWARK, N. J.—The People's Rural Telephone Company has been granted a franchise through Glassboro township.

LEXINGTON, VA.—The Lexington Mutual Telephone Company will improve and enlarge its exchange here at a cost of $5,000.

NEW ALBANY, IND.—The wire is being strung over the right of way for a telephone line which will connect Corydon and DePauw.

PERTH AMBOY, N. J.—The Hudson & Middlesex Telephone and Telegraph Company has been granted a twenty-one-year franchise.

CLEVELAND, OHIO—The Bell Telephone Company has let the contract for the erection of a temporary exchange building at Lakewood.

NORTH TONAWANDA, N. Y.—The Bell Telephone Company, of Buffalo, has been granted a twenty-five-year franchise by the common council.

WELDON, N. C.—The Home Telephone Company will make improvements and extensions to its system here. F. C. Toeplemann is general manager.

RIVERSIDE, CAL.—The Home Telephone Company will erect a new building on Orange street. The laying of the conduit for the cables is progressing rapidly.

RALEIGH, N. C.—The Raleigh Telephone Company has commenced the construction of a line to the town of Clayton. It will be connected with the Raleigh exchange.

CORDELE, GA.—The Farmers' and Business Men's Telephone Company has been granted a franchise to do business here. J. C. Ledbetter is at the head of the company.

GADSDEN, ALA.—The town of Pell City has granted a telephone franchise to George L. Wilson, and within thirty days the line will be under construction. It will connect Pell City, Easonville and Coal City.

MARSHALL, MICH.—The Independent Telephone Company, organized here three years ago, has been sold to the Michigan Telephone Company, it is reported by F. A. Stuart, the principal stockholder.

APPLETON, WIS.—The Fox River Valley Telephone Company has completed its new line to Hortonville. It is the intention of the company to run other lines through different parts of the country as fast as they can be strung up.

SOUTH HAVEN, MICH.—Through the Kibble Telephone Company, which is practically controlled by the Bell company, the Twin City Telephone Company has sold all of the system north of Berrien County to the Kibble people.

DES MOINES, IOWA—The mileage of telephone lines in Iowa increased three and a half times during the past year. Whereas in 1903 it was 14,043 miles, in 1904 it was 48,491 miles. The principal increase was in the rural lines.

ETNA, CAL.—An assessment has been levied on the stock of the Siskiyou Telephone Company, for the purpose of putting the line in better condition. A metallic circuit will be put in from Yreka through Scott valley to Salmon river.

LEECHBURG, PA.—The Apollo Telephone Company has decided to build a new trunk line to Salina, and thence to Avonmore. The pole line will carry six wires and will prove a valuable connecting link with the Indiana County system.

LITTLE ROCK, ARK.—The Sharp Telephone Company will shortly begin the construction of a line from Franklin to Melbourne by way of Philadelphia, a distance of about fourteen miles. This extension will give the company about sixty-five miles of line.

CUMBERLAND, MD.—Preliminary steps have been taken at Keyser for the establishment of an independent long-distance telephone company. A line will be built between Philadelphia, Baltimore and Pittsburg. It will extend through Romney, W. Va.; Cumberland, Piedmont, Keyser, Oakland and Somerset.

MOUNT MORRIS, N. Y.—Work on the new telephone line connecting the villages of Castile, Silver Springs and Gainesville is nearing completion. The exchange will commence business with about 125 subscribers in the three villages. Chiefly interested in the new exchange are Henry A. Pierce, M. N. Cole and E. B. Windsor.

SALT LAKE CITY, UTAH—At a meeting of the county commissioners, the Rocky Mountain Bell Telephone Company was given permission to place its telephone poles between Salt Lake and Union. The Utah Independent Telephone Company were given permission to put telephone poles from here to Bingham and West Jordan.

AMSTERDAM, N. Y.—The Hudson River Telephone Company has sold out its interest in Fulton, Hamilton and Mongomery counties, excepting in the city of Amsterdam, to the Glen Telephone Company, which operates in the three counties. The Glen concern now comes under the trunk line system of the American Telephone and Telegraph Company.

MADISON, MINN.—The farmers of Lac qui Prarie County have organized a telephone company under the name of the Farmers' Mutual Telephone Company. They have made arrangements for connections with the local exchange, and anticipate a large list of subscribers. Work will be started at once on the system, and it is expected that the telephone will be in operation shortly.

KANSAS CITY, MO.—The Argentine city council has granted the Home Telephone Company a franchise in that city. This company now has franchises in Kansas City, Mo., Kansas City, Kan., Rosedale and Argentine. By the terms of the franchise the city is to receive two free telephones and be given the same rates as Kansas City, Mo., with connection for this place to all parts of Kansas City, Mo., or Kansas City, Kan.

WHEELING, W. VA.—The Bell Telephone Company, which of late has been putting in an extensive system of farmers' telephones throughout the county, proposes to put in three new main lines east of the city to further accommodate the rural population. They will run from this city to Elm Grove, whence one will be built out Big Wheeling creek, another on McGraw's run and the other in the direction of Sand Hill. Work will be begun at once.

SPRINGFIELD, ILL.—The Illinois Telephone Company has the long-distance wires between Jacksonville and Decatur in operation. All intermediate points along this route are reached by the independent companies operating in this territory. The line to Rushville has also been finished and intermediate territory in that district is now reached by the offices of the Illinois company. Work is now being pushed on the St. Louis line and rapid progress is being made along this route.

CHESTER, PA.—The Delaware & Atlantic Telegraph and Telephone Company is planning the extension of its cable system from Ridley Park to Glenolden along the western section of these boroughs. It is also rumored that the company contemplates the erection of a central exchange building of its own either in Prospect Park or Glenolden. The present exchange is located in Prospect Park. The company's list of subscribers in that section is rapidly increasing, and larger exchange facilities are needed.

DULUTH, MINN.—The Duluth Telephone Company has made a number of extensions to its line, including one to Pike lake, Adolph, Five Corners and Midway. The company intends running a telephone line around Pike lake next season for the benefit of the campers. The line between Duluth and the ranges has been practically rebuilt. The company has in view an extension to Grand Rapids next season, and a line will be built from Nashwauk to Grand Rapids as soon as there is a suitable road built along which to string poles and wires.

STERLING, ILL.—A deal has been consummated whereby the Farmers' Telephone Company, of Lee County, has purchased the Lee County Telephone Company's exchanges and property in Franklin Grove, Ashton, Amboy, Lee Center, Sublette and Walton. The Farmers' Telephone Company was organized about a year ago by H. W. Hillison. The officers of the company are: president, A. W. Crawford, Franklin Grove; vice-president, G. W. Schafer, Ashton; secretary, J. C. Hunt, China township; treasurer, Christian Gross, Bradford township. These officers and H. W. Hillison, P. L. Berry,

G. M. Finch, W. B. Garrett and H. J. Thomas form the board of directors. The work of rebuilding the system in Dixon is being rapidly pushed along.

TREYNOR, IOWA—A modern local telephone system is contemplated at this place by local capital.

WALDEN, MINN.—A telephone company has been organized at this city to build a line to Starbuck.

NORTH ADAMS, MASS.—A new telephone line is being put in between Williamstown and North Adams.

DES MOINES, IOWA—The Mutual Telephone Company, of this city, will build lines to Adelphi and Ivy soon.

MOLINE, ILL.—The Union Electric Telephone Company will construct a metallic circuit from this city to Taylor Ridge.

SOMERS, CT.—The Southern New England Telephone Company is putting in a new line of wires from Wallop to Somersville.

BARABOO, WIS.—The Baraboo Telephone Company is rebuilding the line between Baraboo and Portage, and between here and Kilbourn.

ARMSTRONG, IOWA—A rural telephone company will be organized in Emmet County in the near future. The principal place of business will be Armstrong.

REDONDO, CAL.—By a unanimous vote the city council passed an ordinance granting for a period of fifty years a franchise to the Home Telephone Company to install its system in Redondo.

BLUE MOUND, KAN.—The local telephone exchange has been sold by C. H. Widener to Chester Smith for $1,300. It is understood that several rural lines are in contemplation and that extensive improvements are to be made soon.

MEMPHIS, TENN.—The Southwestern Telegraph and Telephone Company announces its intention of making extensive improvements in its system throughout the state of Arkansas. Some 40,000 feet of cable for the use of the Little Rock exchange will be strung as rapidly as possible.

NEW WILMINGTON, PA.—Business men of Eastbrook, Lawrence County, have organized a telephone company with fifty subscribers. Two trunk lines will be run to New Castle. A company has also been organized at Plain Grove to install a toll line to New Castle by way of Eastbrook.

SHARON, PA.—The Erie Railroad has asked for estimates for stringing telephone wires along its line between Cleveland and New York. The company has been figuring on telephone equipment for some time. The line, if constructed, will be built on the telegraph poles. The Erie has a telephone service at present between Cleveland and the offices at Galion.

SHELBURNE FALLS, MASS.—At the annual meeting of the Heath Telephone Company these officers were elected: president, W. E. Kinsman; clerk and treasurer, H. Newell; directors, W. E. Kinsman, Fred Kendrick, George E. Davis, D. G. Taylor, F. L. Totman. The company has an exchange of 550 instruments. Its lines extend into Jacksonville, Vt., Colrain, Shelburne Falls, Shelburne town, Conway, Buckland, Charlemont and Ashfield.

MISSOULA, MONT.—Work on the building to be erected by the Bell Telephone Company in this city is to begin at once. It is to be finished and ready for use by January 1. The building is to cost in the neighborhood of $30,000, and the company contemplates important improvements and extensions with its completion. The service in the city is to be bettered and the lines are to be extended in several directions. The company expects to expend about $1,000,000 on improvements and extensions in this county.

EDUCATIONAL NOTE.

FREE LECTURES UNDER THE AUSPICES OF THE DEPARTMENT OF EDUCATION OF THE CITY OF NEW YORK—Henry M. Leipziger, supervisor of lectures, has announced a series of valuable scientific lectures which will be given by the department of education at various places in New York city. These lectures include courses in astronomy, biology, electricity, physics and physical geography. The lectures begin promptly at eight o'clock and the doors are open at 7.30 P. M. Bulletins may be secured from the supervisor.

ENGINEERING SOCIETIES.

THE ENGINEERING ASSOCIATION OF THE SOUTH—The proceedings of the Engineering Association of the South, vol. xv, No. 3, for July, August and September, have been issued. This number includes the minutes of the July meeting, Birmingham section; the minutes of the September meeting, Birmingham section; the minutes of the committee of tellers, and personal and other notes. The papers included are entitled: "Suggestions on the Treatment and Economic Preparation of the Alabama Coals for Coke Manufacturing," by L. A. O. Gabany, and "Concrete and Concrete Costs," by H. M. Jones.

THE SOCIETY OF CHEMICAL INDUSTRY—The local committee of the New York section of the Society of Chemical Industry has issued a prospectus of the society. Any one interested in chemistry may, without any further qualification, be made a member after being formally proposed by at least one member. At the monthly meetings of the New York section papers are read and discussed, after which they are sent to London for prompt publication in the journal of the society. The annual dues are $6.15, which entitle each member to receive the journal of the society. The local secretary is H. Schweitzer, 40 Stone street, New York city.

THE ILLINOIS STATE ELECTRIC ASSOCIATION—At the annual convention of the Illinois State Electric Association, held at Decatur, Ill., October 5 and 6, the following officers were elected for the year: E. B. Hillman, Warsaw, president; Xenophon Caverno, Kewanee, first vice-president; B. H. Abbott, Petersburg, second vice-president; J. A. Carothers, Pontiac, third vice-president; E. S. Hughes, Olney, fourth vice-president; C. A. Vallette, Edwardsville, treasurer; D. Davis, Litchfield, secretary. Executive committee: H. E. Chubbuck, La Salle; J. N. C. Schumway, Taylorville; W. B. McKinley, Champaign; S. S. Davis, Rock Island; Frank J. Baker, Chicago.

JUNIOR MEMBERS OF THE PENNSYLVANIA STATE COLLEGE BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The junior members of the Pennsylvania State College branch of the American Institute of Electrical Engineers gave a banquet to the society on Saturday evening, October 8. More than fifty members were present, and after a repast which was very much enjoyed, an entertainment was indulged in. Among the toasts were: "Our New Members," P. M. Rainey; "Our History," Professor J. P. Jackson; "Social Meetings," C. L. Eshleman; "Esprit de Corps," Dr. R. E. Myers; "Wanderings," A. R. Dennington. The toastmaster was J. C. Chrisman. The regular meeting for October 12 was omitted.

PHILADELPHIA BRANCH, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The thirteenth meeting of the Philadelphia branch of the American Institute of Electrical Engineers was held on Monday, October 10, at the rooms of the Engineers' Club. An interesting paper on "Wireless Telegraphy" was presented by Mr. C. D. Ehret. The paper covered the ground of wireless telegraphy, historically and technically. There was a short discussion in which Messrs. W. C. L. Eglin, McClellan and Braddell took part. The members were then taken under charge of Mr. J. W. Kelley, Jr., to visit the plant of the Keystone Telephone Company at Second and Sansom streets. Through the efforts of Mr. Kelley, Mr. Ulrich, the traffic manager of the company, and their assistants the visit was very interesting and the meeting did not break up until midnight. The next meeting of the branch will be held Monday, November 14.

PENNSYLVANIA STATE TELEPHONE ASSOCIATION—The Pennsylvania State Independent Telephone Association was organized by a number of independent telephone interests at a meeting held at Harrisburg, Pa., on September 27. Following the formal organization, a number of papers were read at the morning session on September 28. A banquet was held on the evening of September 28, a number of prominent telephone men attending. The following officers were elected: B. F. Meyers, Harrisburg, president; R. E. Flinn, Pittsburg, first vice-president; Charles Griffith, Johnstown, second vice-president; H. E. Bradley, Philadelphia, secretary; C. E. Wilson, Philadelphia, treasurer. Executive committee: B. F. Meyers, Harrisburg; C. W. Kline, Hazleton; W. D. Barnard, Philadelphia; G. B. Moody, New York; W. B. Trask, Erie; J. G. Splane, Pittsburg; E. D. Schade, Johnstown; R. E. Umbel, Uniontown; C. E. Wilson, Philadelphia.

PERSONAL MENTION.

PROFESSOR A. E. OUTERBRIDGE read an interesting paper at the Franklin Institute, Philadelphia, Pa., on October 7. The subject of the paper was "The New Theory of Matter."

LUCIUS T. GIBBS, the well-known inventor and builder of many of the electric wagons and trucks operating on the streets of New York, has joined the mechanical staff of the Manhattan Transit Company as mechanical and electrical expert.

MR. WILLIAM E. NIESZ, of the Chicago Edison Company, has accepted the position of editor of the question box for the twenty-seventh convention of the National Electric Light Association. Work has already been begun on this question box. It is thought that by beginning the work thus early, a great amount of valuable information may be secured for the next convention.

MR. FREDERICK A. SCHEFFLER has been appointed special representative of the Stirling company, Chicago, Ill., manufacturer of water-tube safety boilers. Mr. Scheffler's headquarters will be in the New York office of the company, Engineering Building, 114 Liberty street. He will be associated with Mr. A. L. Rogers, district sales manager, and any enquiries pertaining to the Stirling water-tube boiler will receive prompt and courteous attention.

MR. J. A. SHEPLER, district superintendent for the western Indiana district of the Central Union Telephone Company, has resigned, and R. W. Swan has been transferred to Terre Haute. Mr. Swan was formerly district superintendent for the eastern district, with headquarters at Anderson, Ind. Joseph W. Stickney, of the Indiana division headquarters at Indianapolis, has been promoted and placed in charge of the district headquarters at Anderson. M. D. McLean, recently manager at Portland, Ind., has been made manager of the general sublicense department, succeeding C. R. Harris.

PROFESSOR LOUIS DUNCAN, Ph. D., head of the electrical engineering department of the Massachusetts Institute of Technology, has resigned. Professor Duncan is electrical engineer for the New York Rapid Transit Commission and several railroad and telephone companies, and resigns to devote his entire time to these interests. He graduated from the Naval Academy in 1880; later he got the degree of Ph. D. from Johns Hopkins University and resigned from the navy. At the outbreak of the Spanish war, he received the rank of major of the First Volunteer Engineers. He was appointed to the chair of applied electricity in Johns Hopkins University in 1897, and in 1902 went to Technology. Professor H. E. Clifford has been appointed acting head of the department.

MR. JOHN YOUNG, at present general manager of the Glasgow corporation street railways, has accepted a position as general manager of the Metropolitan District Railway, of London, England. The position is a very important one, involving, as it does, the control of the tubes and the railway lines of the companies controlled by Mr. Charles T. Yerkes. Mr. Young has been in the service of the Glasgow corporation since 1875, starting as superintendent of street cleaning. He rose rapidly until, in 1892, he was appointed manager of the city street railways. It was during Mr. Young's superintendence that these lines were converted from horse cars to electric traction. Mr. Young has been a prominent and influential member of the Municipal Tramways Association, of Great Britain, having served in several official capacities.

OBITUARY NOTICE.

MR. ALONZO B. CORNELL, a former governor of New York state, died on October 15 at Ithaca, N. Y. Mr. Cornell had been ill for several months. Alonzo B. Cornell was born in Ithaca, N. Y., January 22, 1832. He was the son of Ezra Cornell, the founder of Cornell University. Ezra Cornell was one of the pioneers who helped develop the use of the telegraph. His son, Alonzo, became a telegraph operator after he had attended the Ithaca Academy. He became, successively, manager, superintendent and director in the original companies and in the Western Union, finally becoming vice-president and president of this company. He was a director of the Western Union Telegraph Company for thirty-one years until 1899. In 1868 he was a candidate for lieutenant-governor of New York, but was defeated. After this he was surveyor of customs at New York, a member of the assembly, and a speaker of the assembly. He was at one time chairman of the Republican state committee, and at another time naval officer of the port of New York. In 1879 he was elected governor, serving until 1883.

ELECTRICAL SECURITIES.

To many the events in the stock market last week gave evidence that, in spite of many statements to the contrary, the outside investing public is taking a decided interest in speculation. It has been pointed out many times that the public is a very strong factor for or against improvement in security values. For the past month there has been a considerable investment demand and coincident absorption. It was feared that this condition was the result of professional manipulation, but the continuance of the upward swing, during the last week particularly, speaks for a stability which will be very hard to undermine. The key to the entire situation, however, lies in the return of confidence on the part of investors. That this confidence will be carried to extremes does not seem likely, owing to the lesson which was learned only a year ago. The general financial and industrial condition shows a marked improvement. Railroad earnings are more favorable than was anticipated, and the crop returns, from the latest government figures, will be valuable and satisfactory. The September record of the railroad gross earnings, it might be remarked, was the best for the year, and indicates an increase over a year ago. There are reports of increased consumption as well as production in the iron and steel industry, and rumors of large orders. The demand for copper continues, and with this new feeling prevailing it does not seem optimistic to hope for a general revival, and even a boom, in construction in general. In this direction electrical undertakings will be among the foremost, as it is upon quick transportation, facilitation of communication and saving of labor that electricity is effecting the greatest reforms to-day.

ELECTRICAL SECURITIES FOR THE WEEK ENDING OCTOBER 15.

New York:	*Closing.*
Brooklyn Rapid Transit	67½
Consolidated Gas	212¾
General Electric	174½
Interborough Rapid Transit	148
Kings County Electric	195
Manhattan Elevated	159½
Metropolitan Street Railway	122¼
New York & New Jersey Telephone	156
Westinghouse Manufacturing Company	190

The second quarterly rental dividend of 1¼ per cent will be paid by the New York City Railway Company to the Third Avenue Railroad Company's stockholders October 31.

Boston:	*Closing.*
American Telephone and Telegraph	140¾
Edison Electric Illuminating	252
Massachusetts Electric	55
New England Telephone	131
Western Telephone and Telegraph	95

Philadelphia:	*Closing.*
Electric Company of America	9 5/16
Electric Storage Battery common	70½
Electric Storage Battery preferred	70½
Philadelphia Electric	7
Union Traction	56¼
United Gas Improvement	97⅛

Chicago:	*Closing.*
Chicago Telephone	128
Chicago Edison Light	155
Metropolitan Elevated preferred	65
National Carbon common	34
National Carbon preferred	108½
Union Traction common	7
Union Traction preferred	34

Chicago Edison directors have declared the regular quarterly dividend of 2 per cent, payable November 1.

It is stated that the new down-town depot of the Metropolitan Elevated will so increase the traffic that the company will easily earn 5 per cent on its preferred stock for the calendar year. A feature of the new depot is that the company saves one-half cent on every passenger at this depot, which it formerly paid to the Union Loop; consequently ten per cent of all passengers handled at the Jackson boulevard terminal will practically be equal to new fares.

Union Elevated reports gross earnings for six months ended June 30, 1904, of $291,588, an increase of $7,330.

NEW INCORPORATIONS.

LA GRANGE, IND.—People's Mutual Telephone Association. $10,000.

DUSHORE, PA.—The Sullivan County Telephone Company. $5,000.

AUSTIN, TEX.—Fort Worth Belt Railway Company. Increased to $500,000.

COLLELE CORNER, IND.—Home Telephone Company. Increased from $1,000 to $25,000.

COLUMBIA, S. C.—Orangeburg & Raymond Telephone Company. $1,000. Incorporators: E. L. Culler and J. G. Smith.

MADISON, WIS.—Pewaukee & Sussex Telephone Company. $2,500. Incorporators: A. T. Larson, S. E. McDowell and William Parker.

GRANTSBURG, WIS.—Mutual Telephone Company. $100,000. Incorporators: Simon Thoreson, Anton M. Anderson and William R. Ahlstrom.

BROWNING, MO.—Browning Telephone Company. $1,070. Incorporators: S. L. Gibson, F. M. Haymaker, M. R. Jenkins, J. J. Smith, E. B. Fields and others.

LONGVIEW, TEX.—Lacey Telephone Company. $35,000. Incorporators: J. C. Lacy, Edwin Lacy and J. W. Yates, of Longview, and Jasper Collins, of Carthage.

LAMONTE, MO.—The Lamonte Telephone Company. $6,600. President, W. E. Piles; vice-president, F. Wimer; secretary, J. A. Fleming; treasurer, John McCurdy.

CHICAGO, ILL.—Rogers Telephone Company for Illinois operates telephone systems. $10,000. Incorporators: George L. Lavery, Albert C. Welch and Frank H. Sellers.

COLUMBIA, S. C.—The Colleton County Telephone Company. $5,000. Incorporators: T. B. Whatley, of Gillisonville; W. F. Gray, of Grays, and C. C. Tracy, of Walterboro.

RALEIGH, N. C.—Kernersville Telephone Company. $5,000. Incorporators: W. C. Linville, G. V. and M. V. Fulp, and A. N. Linville, of Kernersville, and F. W. Lubert, of Waterbury, Ct.

YORK, NEB.—Central Nebraska Toll Line Company. $100,000. Incorporators: C. N. Beaver, H. M. Childs, G. H. Holdeman, W. E. Bell, Herman Hehling, C. H. Kolling and J. J. M. Bell.

HARRISBURY, PA.—Danville & Northumberland Street Railway Company, to build a line from Danville to Northumberland, a distance of ten miles. $60,000. President, Frank C. Angle, Danville.

WICHITA FALLS, TEX.—Wichita Falls Electric Light Company. $15,000. Incorporators: M. B. Lasker, I. H. Kempner, Galveston; Henry Sales, Abilene; R. C. Malone and Frank Kell, Wichita Falls.

WILLIAMSPORT, PA.—The Buffalo Valley Telephone Company. $10,000. Directors: H. H. McClure, G. C. Mohn, William R. Follmer, James Klechner, John P. Ruhl, Charles R. Rule and William Dreisbach.

PITTSBURG, PA.—Tarentum & Brackenridge Street Railway Company, to build a line from Tarentum to Brackenridge, a distance of two and one-half miles. $50,000. Directors: G. B. Findley, Freeport; A. A. McGuire, William M. Fuhrey, Charles D. Gillespie, William White, Jr., Pittsburg.

TALLAHASSEE, FLA.—The Brevard County Telephone Company. To build and operate a telephone line from Cocoa to Eau Gallie, southward fifteen miles; from Cocoa to Titusville, northward twenty miles; and to Courtnay, on Merritt Island, ten miles, and south to Tropic, fifteen miles; to lay cables across Indian river and other navigable streams. $5,000. Incorporators: H. S. Williams, Joseph Paxton, G. S. Hardee, S. S. Jones and R. N. Andrews.

ELECTRIC RAILWAYS.

BIRMINGHAM, ALA.—The Birmingham Railway, Light and Power Company will extend its line to Boyles, a distance of about five miles.

GOSHEN, IND.—An effort is being made to interest Goshen people in the construction of the proposed electric railroad from Huntington to Columbia City.

DENVER, COL.—The Pueblo & Beulah Valley Railroad will, it is announced, shortly be constructed. Holland investors are said to have supplied the necessary capital.

OMAHA, NEB.—Surveyors have begun work on the Omaha & Nebraska Central Railroad. This will connect Millard, Wahoo, Brainard, David City, Osceola and Aurora.

WASHINGTON, PA.—Pittsburg capitalists are back of a movement for the building of a trolley line from Carnegie up the Millers Run valley to Bishop and south to Canonsburg.

PEKIN, ILL.—Work on the Springfield, Lincoln, Bloomington, Peoria & Pekin Interurban Railroad has been commenced at two places along the line between Springfield and Lincoln.

MUNCIE, IND.—It is stated that the Muncie, Hartford City & Bluffton Traction Company is considering the building of a branch line from Eaton, eleven miles north of this city, to Dunkirk and Red Key.

BATON ROUGE, LA.—The survey for the electric line which it is proposed to build between this city and New Orleans has been completed and the engineers found that the line, as laid, is 106 miles long.

HENDERSON, KY.—The Henderson City Railway Company will have a survey made of a prospective electric line to Zion, Ky. There is strong talk of running a traction line from this city to Owensboro.

SEYMOUR, IND.—The Columbus, Greensburg & Richmond Traction Company is now having a survey made of its line, with a view to letting a contract for construction work before the close of the present year.

EDWARDSVILLE, ILL.—John Abscher, representing an electric railway company, is engaged with a force of men surveying a route connecting Olney with Fairfield. The proposed route will pass through the towns of Wynoose and Mount Erie.

UTICA, N. Y.—A Chenango valley trolley line is being considered by a number of capitalists and the farmers along the way. The proposed line runs from Binghamton to Earlville and takes in Bridgewater, Beaver Meadow, Otselic, De Ruyter, Greene, Oxford and Norwich.

ITHACA, N. Y.—The organization of the Ithaca Suburban Railway Company has been completed, and bids for the construction of the proposed second line over East hill from Cornel heights to Renwick park will be solicited. The company has been incorporated for $50,000.

PLYMOUTH, MASS.—A survey for the new Plymouth County road is being made. It will run through Rockland, Hanson, Pembroke, Marshfield and Duxbury to Plymouth. It is expected to construct as much of the road as possible before winter. It will open up a large territory.

PEORIA, ILL.—The board of directors of the Springfield, Lincoln, Bloomington, Pekin & Peoria Electric Company has changed the name of the company to the Corn Belt Electric Company and authorized $900,000 in bonds. The right of way has been obtained between Lincoln and Springfield.

SHARON, PA.—Pittsburg and Cleveland capitalists have organized a company and will build an electric street railway from Sharpsville to Conneaut lake, a distance of fifty miles. The company, which is headed by W. H. Walker, of Cleveland, and C. G. Hussey, of Pittsburg, is capitalized at $1,000,000.

KOKOMO, IND.—After a delay of a year the Kokomo-Marion traction line is to be completed. The line was put in operation from Kokomo to Greentown in 1903. Difficulty was then encountered in procuring financial backing. The Citizens' Loan and Trust Company, of Cleveland, has now furnished the funds required and the

contract for the completion of the road has been let to the Cleveland Construction Company and Rossiter, MacGovern & Company, of New York. The line is to be in operation by January 1, 1905.

INDIANAPOLIS, IND.—Application for a new electric road connecting Indianapolis, Newcastle and Winchester has been filed with the board of public works. Prominent among the incorporators are Charles S. Hernly, Union B. Hunt, James Goodrich and Francis M. Ingler. The line and its branches are to be 140 miles in length.

SPRINGFIELD, MASS.—At a special meeting of the Berkshire Street Railway Company it was voted to issue new bonds to the amount of $200,000 for the purpose of funding the floating debt of the concern. The capital stock of the company is $1,000,000, and the new bond issue will make the bonds equal to this amount.

DANVILLE, PA.—The Columbia & Montour trolley road is to be extensively improved and a new power plant will be erected at Berwick. In it will be installed a 200-kilowatt generator and a 350-horse-power engine. A 150-kilowatt rotary converter will be stationed at Willow Grove, where now there is a 100-kilowatt machine.

ALEXANDRIA, IND.—Representatives of the Indianapolis, Hartford City & Celina Traction Company have applied to the city council for a franchise. The company is said to be amply financed, and will run a line from Celina to Hartford City, Matthews, Alexandria and Lapel to Indianapolis. Franchises have been obtained at Hartford City and Celina.

MEMPHIS, TENN.—A company of capitalists has secured a franchise to construct an electric street railway in West Point, Miss., and is now considering the feasibility of also building an interurban system. The route proposed for the latter enterprise is from West Point to Starkville, thence to Maben and Houston, returning to West Point by way of Aberdeen.

TWO RIVERS, WIS.—It is now practically assured that the electric line connecting this city with Green Bay will be built early next year. The Knox Construction Company, of Green Bay, will build a line from Green Bay to Mishicott, where connection will be made with the Higgins line, which will be built north from here. A franchise will not be asked for, it is announced, but the right of way will be purchased.

PARKESBURG, PA.—The newly chartered Oxford, Cochranville & Parkesburg Electric Railroad Company has decided to issue bonds in a sum not exceeding $300,000. The southern terminus of this road is to be in Oxford. It will extend through the villages of Hayesville, Russellville and Cochranville and the townships of Lower and Upper Oxford, West Fallowfield and Highland, to Parkesburg, a distance of about fourteen miles.

PADUCAH, KY.—J. J. Freundlich, C. E. Whitesides, J. J. Read, Paducah; W. H. Paul, Louisville; Byron Whitesides, New York, and J. and C. Crump, of Columbus, Ind., are the incorporators of the Kentucky & Ohio River Interurban Company, which has filed articles of incorporation. The capital stock is $250,000. This is the company that intends to build an electric line from Paducah to Cairo, taking in the small cities between. It already has most of the right of way.

LA GRANDE, ORE.—Preliminary surveys for the Grand Ronde electric belt railway, for the Eastern Oregon Development Company, has been completed to Elgin, and the surveyors are at the Minam river, six miles above Cove, near the proposed water site. The Minam at this point will generate 20,000 horse-power, which will also be used for manufacturing and other purposes. The grade does not exceed one per cent, with the exception of 1,000 feet, which is two per cent.

CHAMPAIGN, ILL.—An application for incorporation has just been made by the Bloomington, Decatur & Clinton Electric Railway Company, to build an interurban line from Decatur through Clinton to Bloomington with the headquarters of the company in Decatur. The capital stock will be $50,000 and the incorporators will be Harry Shellbarger, of Decatur; W. R. Carle, of Wapella; Edwin Weld and L. M. Murpny, of Clinton; T. N. Leavitt, of Maroa, and H. W. Knight, of Kansas City.

ELGIN, ILL.—The proposed electric line from Belvidere to Elgin will pass through Marengo, from which a branch line will extend to Harvard. When this line is completed the following cities will have connection with Chicago: Rockford, Elgin, Beloit, Janesville, Freeport, Madison, Harvard, Belvidere and Marengo. Passengers from these cities will have electric car service to the following cities, through Chicago: Milwaukee, Racine, Waukegan, Hammond, Joliet, Aurora and Evanston.

ALTON, ILL.—Plans are being considered for making extensive improvements and additions to the power-house of the Alton, Granite & St. Louis Traction Company in Alton. It is proposed to enlarge the plant in order to furnish more power for the new electric line between Alton and St. Louis. The main power plant will be established at Alton with auxiliary plants at Edwardsville Crossing and Granite City. In order to supply the demand for current it will be necessary to make a large addition to the Alton plant.

ALBION, N. Y.—The Albion Electric Railway Company has begun paying farmers for the land needed for the right of way for the road. The Albion & Rochester road is progressing east of the Albion section already built, and by another season will be through. Hundreds of workmen are out on the line. The electric power and light line, which is to run east from Niagara Falls, will come through Albion and go as far as Utica. The Albion Power Company is interested in the enterprise.

CENTRALIA, WASH.—At a meeting of the Centralia council, John B. Weddel, A. S. Caton and W. E. Haycox applied for a franchise for an electric street railway in the city of Centralia. It is their intention to build the road from Tacoma by the way of Olympia, ending at Chehalis. The road would be completed in two years or less, and would eventually run into Portland. Eastern capital is claimed to be behind the deal and as soon as franchises are granted by the important towns the work of buying the right of way and construction is to be started.

HARTFORD CITY, IND.—The work of surveying the right of way of the Indianapolis, Hartford City & Celina Traction line is well under way. The survey of the line between this city and Matthews has been completed, and it is said the line will be in operation by January. The Indianapolis line will parallel no railroads, but will pass through a country traversed neither by steam nor electric roads. It will be 125 miles in length, one of the longest in the state. The concern is financed by the same capitalists who built the Chicago, Elgin & Aurora road.

CONCONULLY, WASH.—Jacob May, fiscal agent of the Mineral Hill Mining Company, states that there is in process of organization a company which will construct an electric railroad extending through the central portion of Okanogan County, from north to south, and on down the Columbia river to Wenatchee, there to meet the Great Northern, and connecting with the Canadian Pacific, in British Columbia, to the nort' The route of the proposed new line lies along the Columbia from Wenatchee to Brewster, thence up the Okanogan to Alma, thence by way of Conconully, Loomis and Oroville to the international line.

ROCHESTER, N. Y.—It is stated that the electric railroad between this city and Elmira, the franchise for which was secured three or four years ago, is now about to be built. The Rochester promoters, according to the report, have interested a number of New York capitalists in the matter who will take over the options and franchises and build the road as soon as the arrangements can be perfected. This line is one of a number which have been contemplated between Rochester and the southern countries. The route is from the city line on the south side through Henrietta, Rush, Greece, Avon, Geneseo, Mt. Morris, Dansville, Sparta, Wayland, Wallace, Cohocton, Corning and Bath and thence on to Elmira.

NEWARK, OHIO—The contract for the construction of the roadbed of the Southeastern Ohio Railway, Light and Power Company's line between Zanesville and Crooksville, has been let to F. H. Blodget & Company, which built the Newark & Zanesville electric road, the contract calling for the completion of the roadbed by the first of May, 1905. The company states that the options for the right of way are being closed as rapidly as possible. Part of the rolling stock has already been contracted for. Eight modern combination passenger, smoking and baggage cars, sixty feet in length, will be put into service as soon as the track and power plant have been completed. It is the intention of the company to have a fifteen-minute schedule between Zanesville and South Zanesville and a regular hourly schedule between Zanesville and Roseville.

INDUSTRIAL ITEMS.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is having great success with its newly perfected Zenith lamps for which it has worked up a good demand.

THE NATIONAL CONDUIT AND CABLE COMPANY, New York, in "Copper Gossip," dated September 10, gives a good resumé of the general outlook of the copper market.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., in bulletin No. 140 calls attention to and illustrates the form M oil switch. This switch was described in the issue of the ELECTRICAL REVIEW for October 8.

S. H. COUCH, INCORPORATED, Boston, Mass., has been chartered to buy, sell, construct and install and manufacture telephones and telephone supplies. The capital stock is stated to be $25,000. Mr. Samuel H. Couch, Boston, is president and treasurer of the company.

THE WILLIAMS ELECTRICAL MACHINE COMPANY, Akron, Ohio, was incorporated at Columbus, Ohio, September 18. The capital stock is $100,000, and the incorporators are H. A. Williams, J. F. Townsend, W. S. Mathias, T. R. Smith and J. R. Welsh. The company will manufacture an electric clutch.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, has produced another series of interesting folders bearing on the commercial rating of incandescent lamps. One of these folders gives some particular information with regard to various forms of incandescent lamp filaments.

THE EMPIRE WIRE COMPANY announces that its main office is now located at the factory in Rome, N. Y. All communications should be addressed direct to this headquarters. The New York city office has been discontinued, and all business will be transacted from Rome, N. Y.

THE UNITED TELPHERAGE COMPANY, 20-22 Broad street, New York city, in circulars Nos. 53 and 54 describes, respectively, applications of electricity to the conveying of ashes from boiler room to cars, and applications for hoisting and transporting material between barges, scows, steamers or sailing vessels and railroad piers or warehouses.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., is distributing an attractive booklet descriptive of single-phase power motors for electric lighting stations. This is a reprint of the masterly paper read by Mr. W. A. Layman before the twenty-seventh convention of the National Electric Light Association, held at Boston, Mass., last May.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., is distributing a souvenir in the form of a handbook containing engineering data in connection with the installation and care of lead-cell storage batteries. This book is made up in the convenient memorandum size, and includes, in addition to the valuable data, several leaves arranged for the incorporation of notes.

THE H. O. S. ENGINEERING COMPANY, 88 Warren street, New York city, is distributing a bulletin descriptive of its all-copper panel-boards. These panel-boards are for various circuits, with and without lugs. The panel-boards are arranged for open-link fuses one and three-sixteenths inches centre to centre. Contact clips for Midget enclosed fuses can be attached by exchanging knurled nuts for plain hexagon nuts.

THE AMERICAN ELECTRIC FUSE COMPANY, Chicago, Ill., announces that the Kaisling self-soldering protector, of which it is the manufacturer, has been adopted by the Merchants' Mutual Telephone Company, of Michigan City, Ind., for use with the new switchboard equipment which is to be installed by the Stromberg-Carlson Telephone Manufacturing Company. The contract calls for 800 pairs for immediate installation.

McLEOD, WARD & COMPANY, New York city, manufacturers of electrical specialties, are distributing a new booklet descriptive of their specialties. Particular attention is called to the 18a fixture, which has been produced to meet a demand for a reasonable priced fixture. This desk lamp is made on the principle of an orchestra lamp, one-half of the cylinder revolving about the other half, so that the opening for light may be almost entirely closed or extended as much as desired. The lamp is equipped with a telescoping arm and with easy means for attaching it to a support.

THE AMERICAN LAVA COMPANY, Chattanooga, Tenn., has published a handsome catalogue descriptive of the nature and physical properties of lava for mechanical and electrical purposes. This material is now being used for manufacture of many industrial devices, prominent among which are electrical insulators. The company will be pleased to send this catalogue and full information upon request.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., has issued a new price list applying to its large general catalogue. The price list is a neat book of 116 pages, and is intended merely as a supplement to the general catalogue. The company states that a number of radical changes have been made in prices, and the book now shows the latest market values in force, and lists, as well, all important new goods. The company will be pleased to send this general catalogue to any one who desires it.

THE CONNECTICUT TELEPHONE AND ELECTRIC COMPANY, Meriden, Ct., has placed on the market new styles of its automatic intercommunicating telephones, and has issued a new bulletin descriptive of this apparatus. This bulletin will be sent on request. The mechanical construction of these telephones is of the highest possible grade. These instruments will interest the exchanges, as well as electrical contractors. The company is distributing its enlarged No. 8 catalogue, which will also be sent upon request.

THE SARCO COMPANY, 906 Sixth avenue, New York city, is again calling attention to its "Noscru" key arm switch. This key arm switch is rather simple in construction, and is installed entirely without the use of attaching screws. The switch portion consists of a porcelain support, through which are drilled two small holes large enough to accommodate the bare conductor. When the bare conductor has been slipped through these holes, it is bent back, making a firm hold without the aid of a binding-post. The action of turning the screw or pressing a button brings a wipe contact into play, which the manufacturer states is positive at all times.

THE WESTERN UNION TELEGRAPH COMPANY, New York city, is distributing a folder bearing the names of the rapid transit subway stations between City Hall and One Hundred and Forty-fifth street, including both the west and east branches. This bulletin also calls attention to the self-winding standard time clocks used in these stations. The Western Union Telegraph Company installs standard time clocks of various designs in offices, halls, stores, factories, engine rooms and dwellings, and connects them by wire, which will regulate them to standard time every hour and give them the Union signal from the United States Naval Observatory at Washington. These clocks are self-winding and can consequently be installed in inaccessible places. An attachment can be put to them that will automatically ring gongs at certain hours. Particulars may be secured by addressing G. C. Newberry, care Western Union Telegraph Company.

THE NEW YORK EDISON COMPANY, New York city, in its bulletin for September, calls attention to a number of interesting installations where Edison service will be used. The Hotel St. Denis is to abandon its private plant, and all of the present steam apparatus will be substituted by electric motive power. Three new electric elevators are to be installed in place of the present hydraulic equipment, and a new electrically operated refrigerating plant of large capacity is to take the place of the plant now operated by steam. The change necessitates the installation of not less than twenty-five separate pieces of electrically operated machinery. An interesting item calls attention to the work in art of Samuel F. B. Morse. While Mr. Morse's name is closely connected with electricity, he was an artist of some renown, having studied with Washington Allston and Benjamin West; and in 1813 he received a gold medal from the Adelphi Society of Arts for his first sculpture, "Dying Hercules."